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AUTHOR Clark, Anthony B.; And Others
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ABSTRACT

The occupational analysis contains a brief job description for the waste water treatment occupations of operator and maintenance mechanic and 13 detailed task statements which specify job duties (tools, equipment, materials, objects acted upon, performance knowledge, safety considerations/hazards, decisions, cues, and errors) and learning skills (science, mathematics/number systems, and communications). The 13 task statements cover the following performance duties: screening and comminuting, grit removal, pumping, flow measurement, pretreatment by chemical addition, coagulation and flocculation, sedimentation and primary and secondary solids removal, sludge wasting and digestion, biological decomposition through sludge process (contact stabilization, step aeration, conventional activated sludge, and extended aeration), biological decomposition through trickling filters, biological decomposition through oxidation lagoons/ponds (flucculative, aerobic, and anaerobic), chlorination, and outfall evaluation. The analysis also includes an appendix containing behavioral science objectives, a list of tools needed to perform each of the two jobs, and a glossary of terms. (JR)

Occupational Analysis

WASTE WATER TREATMENT OPERATOR

Instructional Materials Laboratory
Trade and Industrial Education
The Ohio State University

AN ANALYSIS OF THE WASTE WATER TREATMENT OPERATOR OCCUPATION

Developed By

Anthony B. Clark
Ohio EPA
Dayton, Ohio

Ronald J. Collins
Water Pollution Control
Springfield, Ohio

Martin P. Henning, III
Bowling Green State University
Firelands
Huron, Ohio

George P. Manos
Department of Civil Engineering
Akron, Ohio

Paul G. Mook
Whittier School
Toledo, Ohio

Richard C. Stump
Sanitary Engineer
Summit County
Akron, Ohio

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Director: Tom L. Hindes
Coordinator: William L. Ahsley

The Instructional Materials Laboratory
Trade and Industrial Education
The Ohio State University

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FOREWORD

The occupational analysis project was conducted by The Instructional Materials Laboratory, Trade and Industrial Education, The Ohio State University in conjunction with the State Department of Education, Division of Vocational Education pursuant to a grant from the U.S. Office of Education.

The Occupational Analysis project was proposed and conducted to train vocational educators in the techniques of making a comprehensive occupational analysis. Instructors were selected from Agriculture, Business, Distributive, Home Economics, and Trade and Industrial Education to gain experience in developing analysis documents for sixty-one different occupations. Representatives from Business, Industry, Medicine, and Education were involved with the vocational instructors in conducting the analysis process.

The project was conducted in three phases. Phase one involved the planning and development of the project strategies. The analysis process was based on sound principles of learning and behavior. Phase two was the identification, selection and orientation of all participants. The training and workshop sessions constituted the third phase. Two-week workshops were held during which teams of vocational instructors conducted an analysis of the occupations in which they had employment experience. The instructors were assisted by both occupational consultants and subject matter specialists.

The project resulted in producing one hundred two trained vocational instructors capable of condulting and assisting in a comprehensive analysis of various occupations. Occupational analysis data were generated for sixty-one occupations. The analysis inlcuded a statement of the various tasks performed in each occupation. For each task the following items were identified: tools and equipment; procedural knowledge; safety knowledge; concepts and skills of mathematics, science and communication needed for successful performance in the occupation. The analysis data provided a basis for generating instructional materials, course outlines, student performance objectives, criterion measures, as well as identifying specitic supporting skills and knowledge in the academic subject areas.

PREFACE

Purpose: The purpose of this document is to develop rudimentary occupational job analysis for:

1. Wastewater treatment operators (without supervisory duties)
2. Wastewater treatment maintenance mechanics

Scope: These occupational job analyses cover all commonly used individual steps and processes required for pretreatment, primary, and secondary treatment of municipal wastewaters

Depth: Each major piece of equipment or general grouping (with respect to a specific process) is examined with respect to:

1. operational requirements,
2. maintenance requirements, and
3. sampling, analyzing and performance evaluation

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Rollin M. Barber, Psychology
The Ohio State University
Columbus, Ohio

Jodi Beittel, Communications
Columbus, Ohio

Diana L. Buckeye, Mathematics
University of Michigan
Avon Lake, Ohio

Rick Fien, Chemistry
The Ohio State University
Beachwood, Ohio

N. S. Gidwani, Chemistry
Columbus Technical Institute
Columbus, Ohio

Bruce A. Hull, Biology
The Ohio State University
Columbus, Ohio

Donald L. Hyatt, Physics
Worthington High School
Worthington, Ohio

Glenn Mann, Communications
Columbus, Ohio

Jerry McDonald, Physical Sciences
Columbus Technical Institute
Reynoldsburg, Ohio

Colleen Osinski, Psychology
Columbus Technical Institute
Columbus, Ohio

David Porteous, Communications
University of Connecticut
Colchester, Connecticut

James A. Sherlock, Communications
Columbus Technical Institute
Columbus, Onio

Jim VanArsdall, Mathematics
Worthington High School
Worthington, Ohio

Lillian Yontz, Biology
The Ohio State University
Caldwell, Ohio

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Faith Justice	Research Associate
Sheila Nelson	Administrative Assistant
Marsha Opritza	Editorial Consultant
Rita Buccilla	Typist
Peg Bushelman	Typist
Carol Fausnaugh	Typist
Mindy Fausnaugh	Typist
Rita Hastings	Typist
Carol Hicks	Typist
Sue Holsinger	Typist
Barbara Hughes	Typist
Carol Marvin	Typist
Patti Nye	Typist
Kathy Roediger	Typist
Mary Salay	Typist

JOB DESCRIPTION

Under supervision, performs any combination of the following duties pertinent to controlling the operation of the plant:

1. Operates screening and/or comminuting devices, grit removal equipment, a variety of pumps, flow recorders, chemical addition devices, sedimentation tanks, sludge waste and digestion equipment. activated (aerated) sludge systems, trickling filters, oxidation lagoons/ponds, and disinfection equipment

2. Monitors, records, and reports — meter and gauge readings, in situation laboratory test results, and variations in operating conditions

3. Performs routing operational inspections of the equipment listed in paragraph one, and effluent outfalls, routine maintenance and custodial functions, and in situation laboratory tests and analyses

Duty A Performing Screening and Comminuting

1 Operate screening and comminuting equipment
2 Sample, analyze and evaluate performance of screening and comminuting equipment

(TASK STATEMENT) OPERATE SCREENING AND COMMINUTING EQUIPMENT

TOOLS, EQUIPMENT, MATERIALS OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY - HAZARD
Coarse screen - manually cleaned Coarse screen — mechanically cleaned Comminutor, valves, screenings container Rake, hooks, shovel, boots, squeegee, mop and bucket, hoses, standard operator tool kit Shear pins, nuts, bolts, lock washers	Inspect screens and comminutors Hand clean screens and comminutors Remove debris (screenings) Dispose of debris (screenings) Wash and hose screen and area Lubricate equipment Order maintenance repairs Make minor adjustments Measure and record amount of screenings removed	Slipping on slippery surfaces — keep floor clean Infection by contact with or ingestion of pathogens — innoculation, personal hygiene Keep ventilation fans on Asphyxiation by toxic gases Suffocation from oxygen deficiency Explosion or fire from flammable solvents Pinched against moving machinery — guards

DECISIONS	CUES	ERRORS
Select number of screens and comminutors in service Determine whether to increase operating frequency Determine whether to make minor repairs or remove from service Determine whether to clean jammed or plugged screen or comminutor or to order cleaning by maintenance	Flow volume, odor, appearance Build up on screens Electrical or mechanical overload, seared pin, abnormal noise, excessive heat in motor or drive mechanisms High water level in inlet channel	Too much build-up on screens, debris forced through screen or grit settles ahead of screens Too much build-up on screens or excessive wear on equipment Lack of attention to other operating units or by-passing of plant flow

TASK STATEMENT) OPERATE SCREENING AND COMMINUTING EQUIPMENT

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [cleaning devices are simple tools] Effect of heating and cooling on expansion of materials [binding due to thermal expansion] Resistance of materials to change in shape [shear pin] Behavioral science (see appendix)	Rational numbers Fundamental operations (calculation) Addition algorithm Subtraction algorithm Multiplication algorithm Division algorithm Order of operations, i.e., use of parentheses in simplifying arithmetic expressions Changing mixed numbers to improper fractions Property of comparison – equality/equivalence, inequality/greater than/less than Basic measurement skills and concepts – rate Measurement: geometric – linear, area, and volume Measurement: non-geometric – speed [velocity] Knowledge of geometric relationships – parallel and perpendicular

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, description of mechanism, and process report–instructions
Writing		Memo format, description, and terminology/general vocabulary
Listening		Noise discrimination (recognize proper and improper sounds; animal, human, machine)
Viewing		Visual analysis (seeing the parts in relation to the whole)
Touching		Temperature, vibration, pressure
Smelling		Flammable solvents, hydrogen sulfide

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF SCREENING AND COMMINUTING EQUIPMENT

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Sampling dipper Thermometer Sample containers Graduated cylinders Dissolved oxygen sampler Refrigerator Automatic sampler Alkaline potassium iodide Manganous sulfate Concentrated sulfuric acid (dissolved oxygen reagents) Sample preservatives when necessary Influent and effluent from screens and comminutors	Sample raw influent per schedule Measure and record temperature per schedule Composite representative sample in proportion to flow Label and preserve samples per schedule For dissolved oxygen, sample raw influent using dissolved oxygen sample Fix dissolved oxygen sample to convert oxygen to iodine per Manual Operating Practice 18 Transport sample to laboratory for analysis Transport composite sample to laboratory Obtain an extra sample when abnormal color or odor is noted in sewage and promptly transport to the laboratory Observe other units in the plant for signs of malfunction of screening units From above tests and observations, make necessary adjustments on equipment Measure and record volume of screenings collected (cubic feet, cubic yards, bucketful, etc.)	Handling mercury from comminutor seal -- avoid contact from fumes or liquid mercury Infection by contact with or ingestion of pathogens Keep ventilation fans on Asphyxiation by toxic gases Suffocation from oxygen deficiency Explosion or fire from flammable solvents Pinched against moving machinery -- guards Slipping on slippery surfaces -- housekeeping, rubber mats, skid-proof surfaces Back strain through improper lifting -- proper lifting techniques Electrical shock from improperly grounded electrical equipment -- ground rubber mats Electrical shock -- lock out equipment before working on it

DECISIONS	CUES	ERRORS
Determine whether to throw sample of raw influent out as unrepresentative and get another sample Determine if sample is representative Determine if there is oxygen in sample Determine whether to take an extra sample Determine whether to readjust or rebuild screens and comminutor	Abnormal appearance Simple tools High or low analytical results No yellow color Color or odor Rags, trash in settling tanks or pumps	Results too high or low, improper technique Improper mixing of sample, non-representative sample, skipped sample in composite Continuing test where results will be zero Inhibit bacterial growth in biological systems Damage to equipment, pumps

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF SCREENING AND COMMINL .G EQUIPMENT

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Behavioral science (see appendix)	Rational numbers Fundamental operations (calculation) – addition, subtraction, multiplication, and division algorithms, and ordering of operations, i.e., use of parentheses in simplifying arithmetic expressions [computing amount of composite sample] Basic arithmetic skills and concepts – ratio and proportion, and estimation; changing mixed numbers to improper fractions [thermometer, graduated cylinder, pipettes] Basic measurement skills and concepts – measurement: geometric - volume – measurement: non-geometric - time, date, temperature

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, process report–instructions
Writing		Memo format
Listening		Auditory discrimination, and noise discrimination(recognize proper and improper sounds; animal, human, machine)
Viewing		Visual analysis, describing, detail and inference and color discrimination
Smelling		Odor

Duty B Performing Grit Removal

1 Operate hand cleaned grit chamber
2 Operate mechanically cleaned grit chamber
3 Sample, analyze, and evaluate performance of grit chamber

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(TASK STATEMENT) OPERATE HAND CLEANED GRIT CHAMBER

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Standard Operators Tool Kit Valve key or hook Shovel and scapper Bucket, wheel barrow, truck Water hose Grit containers Grit removing vehicle Wet suit (boots) Broom Hard hat Grit channels Grit Materials reporting log Pencil	Close flow gate in chamber Open influent gate on new chamber Open drain plug, with proper technique Shovel material into container Transport grit to disposal site Wash down chamber Close drain plug Record amount of grit	Proper lifting procedure Pay attention to footing Personal hygiene Strained muscles Falling Infection Head injuries
DECISIONS	**CUES**	**ERRORS**
Determine if chamber needs cleaning	Depth of settled material	Insufficient grit, cleaned, time wasted Sufficient grit, not cleaned, generation of foul odor, and grit in areation tank

(TASK STATEMENT) OPERAT~ HAND CLEANED GRIT CHAMBER

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Forces acting on a body immersed or floating in a liquid [sedimentation – weight of grit, flow or speed] Behavioral science (see appendix)	Set of real numbers [positive rationals] irrationals/rationals fractions/decimals integers whole numbers counting Basic measurement skills and concepts "measure sense"/role of "unit" measurement: geometric - linear

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Viewing		Visual analysis (seeing the parts in relation to the whole) Memory (short and long term retention) Describing (discrimination and verbalization of physical characteristics) Detail and inference
Smelling		Noting degree of foul smell

(TASK STATEMENT) OPERATE MECHANICALLY CLEANED GRIT CHAMBER

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Tools -- standard operating tool kit Recording log Grease Oil Wet suit Boots Hard hat Gloves Scraper Grease gun Oil can Pencil Shovel Broom Motors Grit removing device or devices installed on plant site Grit containers, grit removing vehicle Grit	Operate particular mechanical grit removal unit in accordance with manufacturers instructions Lubricate all moving parts Observe all moving parts for wear Hose down and clean channel walls and conveyer belts Empty grit hopper Remove grit to disposal area Record and report volume of grit collected	Good footing Beware of moving parts Personal hygiene Hard helmet (close quarters) Falls Injuries to extremities Infections Head injuries

DECISIONS	CUES	ERRORS
Determine whether manufacturer's maintenance is required Determine whether to lubricate as needed Determine whether to adjust clearance if possible or report condition to supervision Determine whether to hose down or scrape off surface of walls or belts as needed Determine whether to empty grit hopper Determine whether to remove grit from storage containers to disposal site Determine whether to record and report volume of grit, noting abnormalities	Instructions in manufacturer's maintenance Lubrication schedule or squeaks and noises Unusually shinny appearance or excessive tolerance between moving parts Accumulation of solids or slimmy wastes on surface of walls or belts Full grit hopper or excessive foul odors Unsanitary appearance or foul odors of storage containers Daily operating log schedule	Failure of mechanical equipment, loss of time, expense of repair Slippery, unsafe, unsanitary conditions, foul odor generation Need for excessive grit containers, generation of foul odors, unsanitary conditions Failure to keep operating records needed to detect possible pending equipment failure, and grit accumulation in aeration tanks

(TASK STATEMENT) OPERATE MECHANICALLY CLEANED GRIT CHAMBER

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Centrifugal forces developed by bodies in rotation [rotating cyclone separator] Centripetal forces developed by bodies in rotation [rotating cyclone separator] Forces acting on a body immersed or floating in a liquid [sedimention rates] Behavioral science (see appendix)	Set of real numbers – positive rationals Irrationals/rationals, fractions/decimals, integers, whole numbers, and counting Fundamental operations (calculation) Addition, subtraction, and multiplication algorithms Reduction of fractions Changing mixed numbers to improper fractions Use of computing devices and mechanical aids Calculators – electrical "Measure sense"/role of "unit" Conversion from one standard unit to another

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, enunciation
Reading		Comprehension, informational reports, physical experiment reports, terminology, process reports – instructions
Writing		Reports
Listening		Auditory discrimination,concentration, noise discrimination (recognize proper and improper sounds; animal, human, machine)
Viewing		Visual analysis, memory, color discrimination, and recognition of symbols, codes, emblems
Touching		Temperature, motion, pressure, torque
Smelling		Recognition, degree, and change

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF GRIT CHAMBER

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Container and stick Recording forms Grit removal tank Grit	Record total volume grit collected Record any observed abnormalities Collect representative sample Send sample to laboratory Determine volatile content of grit collected in order to evaluate efficiency of grit chamber operation	Personal hygiene Safe footing Infection Falling
DECISIONS	**CUES**	**ERRORS**
Determine if abnormality exists Determine whether to record or not record	Variation from normal appearance, color, size, etc.	Failure to observe and/or record will result in no corrective action by supervisory personnel Excessive loading plant process Possible mechanical equipment failure

TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF GRIT CHAMBER

SCIENCE	MATH – NUMBER SYSTEMS
Understand "representative" sampling Behavioral science (see appendix)	Set of real numbers – positive rationals Irrationals/rationals, fractions/decimals, integers, whole numbers, and counting Use of numbers (without calculation) – recording "Measure sense"/role of "unit" Measurement: geometric Linear, area, and volume Measurement: non-geometric Weight

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Writing	Doing log reports	Penmanship Spelling Reports Terminology/general vocabulary
Vi· ng	Observing sample condition	Visual analysis (seeing the parts in relation to the whole) Describing (discrimination and verbalization of physical characteristics) Color discrimination
Smelling	Not normal odor	

Duty C Performing Pumping

1 Operate centrifugal and positive displacement pumps

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(TASK STATEMENT) OPERATE CENTRIFUGAL AND POSITIVE DISPLACEMENT PUMPS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Standard operators tool kit Pump, switch, lock out tag, Operating manual Flashlight, electrical continuity tester Hoses, gloves, boots, and hard hats Check valves Shut-off valves Sump pumps Grit pumps Sewage pumps Activated sludge return pumps Trickling filter return pumps Digester circulating sludge pumps Digester supernatent return pumps	Inspect pump for normal operation Start up and shut down pumps per operating procedures Inspect pump activating controls – electrode controls, air bubbler, and float switch Determine cause of any malfunction Make minor adjustments as necessary Lubricate Order maintenance repairs Record pump data per operating procedures Record process changes and operating difficulties	

DECISIONS	CUES	ERRORS
Determine whether to shut pump down or let run Determine whether to follow operating procedures Determine when to order repairs	Noise, heat, will not start, lost prime, vibration, discharge pressure, suction pressure, amperage, excessive packing leakage, wobble, slippage in belt drive, failure in seal water system, cut-in and cut-out cycles too frequent Line blows apart on positive displacement pump Parts needed	Damage to pump (burn out motor, bend shaft, bind rotating element, damage wearing rings, excessive wear or breakage of impeller, damage pump seal) Valve left closed on discharge side Delay may result in poor plant performance

ASK STATEMENT) OPERATE CENTRIFUGAL AND POSITIVE DISPLACEMENT PUMPS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Effect of heating and cooling on expansion of materials [binding due to overheating] Fluids under pressure [pressure sensing devices – hydrostatic and pneumatic pumps] Centrifugal forces developed by bodies in rotation [centrifugal force (pump impeller)] Resistance of materials to change in shape [bending of shafts, float rods] Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition, subtraction, multiplication, and division algorithms, and order of operations, i.e., use of parentheses in simplifying arithmetic expressions Basic arithmetic skills and concepts Ratio and proportion – estimation ; property of comparison, equality/equivalence, inequality/greater than/less than –[return activated sludge, and hydrostatic pressure, electrical amperage] Basic measurement skills and concepts – instruments: tachometer, tape, and liquid level drop rate – [flow] measurement: geometric–volume [cubic measure] measurement: non-geometric – temperature, and speed (for example: feet per minute, R.P.M., etc.)

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, process report–instructions
Writing		Memo format
Listening		Noise discrimination (recognize proper and improper sounds; animal, human, machine)
Viewing		Visual analysis (seeing the parts in relation to the whole), and describing (discrimination and verbalization of physical characteristics)
Touching Smelling		Temperature, motion–vibration, and pressure Odor – burning, overheating: electric or oily

Duty D Performing Flow Measurement

1 Operate flow measurement devices

(TASK STATEMENT) OPERATE FLOW MEASUREMENT DEVICES

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD 26
Hose Pen cleaning wires Ink Charts Pen Voltage tester Electrical continuity tester Rotameter Parshall flume Flow nozzle Weir (rectangular V-notch, cipollette, sutro) Velocity meter Differential head meters Orifices Magnetic meters Sensing, indicating, transmitting, and recording devices	Inspect equipment for proper operation Record flow readings Change chart Check and refill pen cleaning clogged tips Clean float of debris and wash down stilling well On pneumatic systems, blow down condensate trap Clean wires and flow nozzles as required Diagnose malfunctions and correct if possible Order maintenance repairs when malfunction is noted	Slipping on slippery surfaces – housekeeping skid-proof floors Ventilation in closed areas required to prevent asphyxiation or suffocation – keep fans on while in area

DECISIONS	CUES	ERRORS
Check power supply on transmitter and recorder; check recorder electron tubes Check float cables, power supplies, blockage in stilling well, floats	Sensing but not indicating correctly Indicating but not recording No reading Erratic reading Wrong reading	Wrong flow readings Poor analysis of plant performance – flow devices may falsely control other plant units

ASK STATEMENT) OPERATE FLOW MEASUREMENT DEVICES

SCIENCE	MATH – NUMBER SYSTEMS
Fluids under pressure [venture, air bubbler, and liquid head] Forces acting on a body immersed or floating in a liquid [floats] Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation): addition,subtraction, multiplication, and division algorithms, and order of operations, i.e., use of parentheses in simplifying arithmetic expressions Ratio and proportion – estimation [determine peak, average, and minimum flow] Basic measurement skills and concepts: Instruments: flow indicator and recorder Rate [flow] Measurement: geometric – volume measurement [cubic feet per second–million gallon per day] Measurement: non-geometric – liquid and speed (example: feet per minute, R.P.M., etc.) Conversion from one standard unit to another [gallons per day to pounds per day or to cubic feet per second]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, description of mechanism, and process report – instructions
Writing		Memo format, record flow, initiate repair order
Listening		Auditory discrimination
Viewing		Describing (view and describe malfunction)
Touching		Temperature, pressure, and motion vibration

Duty E Performing Pretreatment by Chemical Addition

1 Operate pretreatment units (chemical addition)
2 Sample, analyze, and evaluate performance of pretreatment units (chemical addition)

(TASK STATEMENT) OPERATE PRETREATMENT UNITS (CHEMICAL ADDITIONS)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Standard operating tool kit Pipe reamer Hand and power carts, conveyors, rollers, Zeta meter, hydrometer, and charts turbidimeter, pH meter, oxidation-reduction meter (ORP) Alum, lime, carbon, fly ash, polymets, sodium aluminate, ferris chloride, ferrous sulfate and chlorine, and ferric sulfate Chemical feeders (wet and dry), chemical storage and transport system, mixing tanks (flash and slow mix), measuring devices – weight and volume, dust collectors, chemical additions control	Check inventory of materials Fill bins of chemical feeders Prepare solution feeds Check feed rates in proportion to chemical reactions Check dosages of chemicals required Inspect and adjust equipment for proper operation Obtain laboratory results and readjust chemical dosages Start up and shut down units Lubricate equipment Make minor repairs Order maintenance repairs Sample chemicals for purity as purchases	Dust mask for loading and unloading of hazardous chemicals – danger of explosives Slipping on slippery surfaces – housekeeping, skid-proof surfaces Chemical burns in cuts Eye protection (shields-glasses) when loading or unloading hazardous chemicals Ferric chloride, liquid alum – rubber aprons, knee boots, and eye protection

DECISIONS	CUES	ERRORS
Determine whether to turn on dust collection system and exercise care in handling Determine whether to check solution concentration Determine whether to break up or remove blockage – correct feed rates	Carbon dust in room atmosphere Chemical reaction incomplete Caking of dry chemical Zeta potential high or low	Explosive dust mixture Poor treatment Underfeed chemical – poor treatment Overfeed chemical – poor treatment

ASK STATEMENT) OPERATE PRETREATMENT UNITS (CHEMICAL ADDITIONS)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Effect of heating and cooling on state of matter [keeping chemicals in solution] Fluids under pressure [hydrostatic head] Transfer of heat from one body to another [chemistry – stoichiometric proportions; chemistry – colloids, zeta potentials, pH and ORP] Effects of particle size on flow rate of dry powdered chemicals Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition, subtraction, multiplication, and division algorithms; and order of operations, i.e., use of parentheses in simplifying arithmetic expressions Ratio and proportion – setting feeders, and making dilutions Instruments: Thermometer, tipping bucket, proportioning pump Rate – feed rates – mass and volume Measurement: geometric – volume Measurement: non-geometric – temperature, weight, liquid, dry, and speed (example: feet per minute, R.P.M., etc.) Use of variables: in formulae, and in equations Manipulation of formulae; write as a formula or equation a relationship given in words; substitute given values in order to find the value of the required unknown [determine chemical proportions in stoichiometry] Determination of lateral area, total area, and volume of frustums of pyramids and cones [calculate volumes in bins]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, process report – instructions
Writing		Memo format
Smelling		Odor
Listening		Auditory discrimination, noise discrimination (recognize proper and improper sounds; animal, human, and machine)
Viewing		Visual analysis, describing
Touching		Consistency, texture, temperature, motion-vibration, pressure

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF PRETREATMENT UNITS (CHEMICAL ADDITION)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Sample dipper Six gang mixer Zeta meter pH meter Turbidity meter ORP meter Beakers Hydrometer Membranes Standard samples pH probe pH probe cleaner Calomel solutions Distilled water Chemicals Influent	Take representative sample of each batch of delivered chemicals and send to laboratory for analysis of quality and purity Take samples of chemical dilutions for laboratory analysis or hydrometer test Test solutions for proper dosage concentration Make jar tests to determine optimum dosage required	Dust mask for loading and unloading of hazardous chemicals--danger of explosions Slipping on slippery surfaces -- housekeeping, skid-proof surfaces Chemical burns in cuts Eye protection (shields, glasses) when loading or unloading hazardous chemicals Ferric chloride, liquid alum -- rubber aprons, kneeboots, and eye protection

DECISIONS	CUES	ERRORS
Determine whether to reject sample or accept with proper adjustments Determine whether to rerun on-site tests Determine whether to rerun check for change in influent	Material not as specified Material frozen Laboratory analysis does not agree with tests Higher dosage than normal operating experience	If rejected, may run out of chemicals Use wrong dilution Add excessive chemicals

ASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF PRETREATMENT UNITS (CHEMICAL ADDITION)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Chemistry: stoichiometric proportions, colloids, zeta potential, pH, and ORP Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition, subtraction, multiplication, and division algorithms, and order of operations, i.e., use of parentheses in simplifying arithmetic expressions Ratio and proportion – estimation [dilutions] Instruments: proportions Rate [feeds] Measurement: geometric – volume Measurement: non-geometric – temperature, weights, liquid, dry, and speed (example: feet per minute, R.P.M., etc.) Use of variables: in formulae, and in equations: manipulation formulae Write as a formula or equation a relationship given in words Substitute given values in order to find the value of the required unknown [determine chemical proportions in stoichiometry] Determination of lateral area, total area, and volume of frustums of pyramids and cones [calculate volumes in bins]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, process report – instructions
Writing		Memo format
Listening		Auditory discrimination, and noise discrimination (recognize proper and improper sounds: animal, human, and machine)
Viewing		Visual analysis (seeing the parts in relation to the whole)
Touching		Consistency, texture, temperature, pressure
Smelling		Odor

Duty F Performing Coagulation and Flocculation

1 Operate coagulation and flocculation units
2 Sample, analyze, and evaluate performance of coagulation and flocculation units

(TASK STATEMENT) OPERATE COAGULATION AND FLOCCULATION UNITS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Standard operators tool kit Sample dipper Zeta meter pH meter Turbidimeter Graduated cylinders Timers Oxidation-reduction potential meter (ORP) Membranes Standard samples pH probe cleaner pH probe Calomel solutions Distilled water Coagulation and flocculation tanks Valves Hydrometer	Observe for normal operation Check and determine causes of malfunctions Adjust mixing and flocculating rates Check size, shape, and settling rates of flocculation Make minor repairs — linkages -- drives Order maintenance repairs Order changes in chemical additions and feed rates Check and recalibrate sensing probes (Zeta meter, pH meter, turbidimeter) Start up and shut down units	Slipping -- on slippery surfaces; clean up oil, slimes, and wet spots Falling into tank — exercise caution; body balance; watch footing Body strains — lift heavy bags carefully

DECISIONS	CUES	ERRORS
Determine whether to clean, check, and/or replace sensors on Zeta meter, pH meter, and turbidimeter Determine whether to check chemical feed rate and check power supply and controls Determine whether to increase peripheral velocity of flocculators Determine whether to increase chemical feed — reduce flocculator speed Determine whether to increase chemical reaction time Determine whether to administer excessive dosage	Sensors not indicating correctly No flocculation formation Flocculators off Sludge settling to bottom of flocculators Light flocculation Pinpoint flocculation Dense flocculation High or low hydrometer readings	Excess addition of chemical, poor treatment Manually remove sludge Overload equipment Poor performance Poor plant performance Waste chemicals

ASK STATEMENT) OPERATE COAGULATION AND FLOCCULATION UNITS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple machines] Chemistry – stoichiometric proportions Chemistry – colloids – Zeta potentials Chemistry – pH, ORP Chemistry – specific gravity, degrees Baumé Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition algorithm Subtraction algorithm Division algorithm Order of operations, i.e. use of parentheses in simplifying arithmetic expressions

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, process report – instructions
Writing		Memo format
Listening		Auditory discrimination, and noise discrimination (recognize proper and improper sound; sounds; animal, human, and machine)
Viewing		Visual analysis (seeing the aprts in relation to the whole), memory (short and long term retention), recognition of symbols, codes
Touching		Temperature, motion-vibration, pressure
Smelling		Odors

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE, PERFORMANCE OF COAGULATION AND FLOCCULATION UNITS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Sample dipper Graduated cylinders Timer Zeta meter pH meter ORP meter Turbidity meter Burette-erlenmeyer flasks Membrane Standard sample pH probe pH probe cleaner Calomel solutions Distilled water Standard acid solution (.02 N) Phenolphthalein and methyl orange indicator Objects -- influent and effluent Samples Hydrometer	Take representative samples of influent and effluent for laboratory analysis and on-site analysis Composite in proportion to flow samples for laboratory analysis Test influent and effluent for turbidity, pH, ORP , Zeta potential, alkalinity, according to plant operating schedule or under abnormal operating conditions Record results and notify proper operating personnel to make necessary adjustments	Slipping -- on slippery surfaces; clean up oil, slimes, and wet spots Falling into tank -- exercise caution; body balance; watch footing

DECISIONS	CUES	ERRORS
Determine whether to change chemical feed	High turbidity Low or high pH Low or high ORP High Zeta potential Low or high alkalinity High or low hydrometer readings	Poor treatment; high chemical usage

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF COAGULATION AND FLOCCULATION UNITS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple machines] Chemistry: stoichiometric proportions, colloids – Zeta potential, pH, ORP Chemistry – specific gravity, degrees Baumé Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition algorithm Subtraction algorithm Multiplication algorithm Division algorithm Order of operations, i.e. use of parentheses is simplifying arithmetic expressions

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening Viewing Touching Smelling		Terminology/general vocabulary Comprehension, process report – instructions Memo format Auditory discrimination Visual analysis (seeing the parts in relation to the whole), describing (discrimination and verbalization of physical characteristics), color discrimination, and recognition of symbols, codes, emblems Pressure Odor

Duty G Performing Sedimentation (Primary and Secondary Solids Removal)

1 Operate mechanically cleaned settling tanks
2 Sample, analyze, and evaluate performance of mechanically cleaned settling tanks
3 Operate Imhoff settling tank
4 Sample, analyze, and evaluate performance of Imhoff settling tank

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(TASK STATEMENT) OPERATE MECHANICALLY CLEANED SETTLING TANKS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Standard operators tool kit Hose Brush Cleaning rod Grease gun Oil containers Boots Rainsuit Pencil and paper Operating report forms Maintenance report forms Lubrication Record cards Settling tanks Sludge and scum collector mechanisms Overflow weirs Baffles, sludge well, telescoping sludge valves, sludge withdraw line, and scum discharge system	Inspect settling tank for proper operation Inspect torque limit system Operate sludge collector and skimmer Draw off sludge Remove scum (floatable materials) Clean scum removal and collector mechanism Pump raw and secondary sludge Place settling tanks in and out of service Clean baffles and weirs per schedule Check oil level in gear drive mechanism per schedule Lubricate per schedule Make minor repairs Order maintenance repairs Watch torque indicator for evidence of scraper overload	Slipping on slippery surfaces – clean up oil, grease, watch footing Infection by contact with or ingestion of pathogens – wash hands before eating or smoking; hands below collar while working; prompt first aid for all minor cuts; prompt medical attention to all major cuts and puncture wounds Falling into tank – watch footing

DECISIONS	CUES	ERRORS
Determine if sludge build up in tank is due to mechanical or electrical malfunction Determine if hydraulic overload exists Determine whether to operate skimmer Determine whether to operate sludge collector Determine whether to remove load on sludge collector Determine whether to inspect for worn or broken parts Determine whether to allow sludge to thicken in tanks before drawing off Determine whether air locked or blocked line Determine whether to change number of settling tanks in service – drain out any water or oil	Thermal overload of motor Excessive heat, abnormal noise Excessive loss of solids over weirs Visible grease particles discharging from weir Rising sludge Odors of hydrogen sulfide Tank dark Gas bubbles on tank High torque indication on drive mechanism Erratic movement stuttering of sludge Sludge low in percent solids to digestion Pump not pumping Flow rate through tank, turbidity, color of submerged weir Water in oil reservoir	Damage to collector Reduced efficiency Clogged trickling filter or overload Activated sludge tank with hard to remove grease balls Damage to collector Damage to collector and skimmer Damage to mechanism Exceed sludge heating system capacity and hydraulic overload digestion system No sludge transferred Hydraulic overload or underload Damage to drive mechanism

(TASK STATEMENT) OPERATE MECHANICALLY CLEANED SETTLING TANKS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [cleaning devices are simple tools] Forces acting on a body immersed or floating in a liquid [settling rates (Stokes Law)] Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition, subtraction, multiplication, and division algorithms, and order of operations, i.e., use of parentheses in simplifying arithmetic expressions Changing mixed numbers to improper fractions Property of comparison – equality/equivalence, inequality/greater than/less than Basic measurement skills and concepts Rate Measurement: geometric – linear, area, and volume Measurement: non-geometric – speed [velocity] Basic geometry skills and concepts Knowledge of geometric relationships – parallel, and perpendicular

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening Viewing Touching Smelling		Terminology/general vocabulary Comprehension, description of mechanism, process report – instructions Memo format, description, and terminology/general vocabulary Noise discrimination (recognize proper and improper sounds; animal, human, machine) Visual analysis (seeing the parts in relation to the whole) Temperature, vibration, pressure Flammable solvents, hydrogen sulfide

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE, PERFORMANCE OF MECHANICALLY CLEANED SETTLING TANKS

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Sampling dipper Thermometer Sample containers Graduated cylinders D.O. Sampler Sterile bacterial bottle Raincoat Refrigerator Automatic sampler D.O. glassware D.O. reagents Influent and effluent from settling tanks (primary and secondary)	Sample influent and effluent per schedule Measure and record temperature per schedule Composite representative sample in proportion to flow Label and preserve samples per schedule Fix samples and test for D.O. Transport samples to laboratory Observe other units in the plant for signs of malfunction of settling units From the above tests and observations, make necessary adjustments on equipment to improve or maintain optimum plant performance Determine sludge volume index and sludge density index in order to properly evaluate operation of settling tanks	Slipping on slippery surfaces – clean up oil, grease, watch footing Infection by contact with or ingestion of pathogens – wash hands before eating or smoking; hands below collar while working; prompt first aid for all minor cuts and puncture wounds Falling into tank – watch footing

DECISIONS	CUES	ERRORS
Determine whether to initiate corrective action Determine whether to check sample collection method Determine whether to initiate corrective action, fix skimmer, increase frequency of removing skimmings	Abnormal appearance, color, turbidity solids overflow High or low results Solids carry over (excessive) Rising sludge blanket Trickling filter ponding Excessive floating solids in aeration tank (debris, grease)	Poor efficiency of treatment Non-representative samples Poor efficiency also filter ponding, clogging lines, and valves, creates additional manual cleaning problems in subsequent units

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF MECHANICALLY CLEANED SETTLING TANKS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Chemistry – normality, conversion of units, standardization of solutions, oxidation-reduction reactions Biology, bacteriology – some knowledge of aquatic plants, animals, bacteria and molds, pathogens, fecal coliform Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition algorithm Subtraction algorithm Multiplication algorithm Division algorithm Order of operations, i.e., use of parentheses in simplifying arithmetic expressions [computing amount of composite sample] Basic arithmetic skills and concepts Ratio and proportion – estimation Changing mixed numbers to improper fractions [thermometer, graduated cylinder, pipettes] Measurement: geometric Volume Measurement: non-geometric Time [date] Temperature

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening Viewing Touching Smelling		Terminology/general vocabulary Comprehension, process report – instructions Memo format, sample tags, forms, reports Auditory discrimination, and noise discrimination (recognize proper and improper sounds animal, human, and machine) Visual analysis, describing, detail and inference color discrimination, appearance of sample and units, reports Pressure Odor – recognize various types (pungent, aromatic, earthy, sour, etc.)

(TASK STATEMENT) OPERATE IMHOFF SETTLING TANK

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Long handled squeegee Skimmers slot cleaner Storage containers Hose Chemical – hydrated lime Valves Imhoff tank Long chain	Inspect gas vents weirs, settling compartment Observe for gas in settling compartment Break up scum in gas vents Squeeze settled solids through slot Clean slot Reverse flow in tank as necessary Draw off sludge as necessary Housekeeping Order maintenance repairs	Slipping on slippery surfaces – watch footing and clean up grease and oil Fall into tank No smoking in immediate area – methane gas Avoid breathing lime and handling lime with bare hands – lime dust – use dust mask, gloves, rubber apron

DECISIONS	CUES	ERRORS
Determine whether to break up surface scum Determine whether to clean slots Determine whether to remove settled solids from settling compartment Determine whether to draw off sludge from sludge digestion compartment Determine whether to backflush sludge draw-off line with water Determine whether to break up scum in gas vents and add hydrated lime Determine whether to check inlet and outlet valves	No gas rising in gas vent Gas rising in settling compartment Sludge rising in settling compartment Line of gas bubbles over slot Blocked sludge draw-off line Odors Rising water level in settling compartment	Lower treatment efficiency Unit out of service Odors, lower treatment efficiency Reduced unit capacity

(TASK STATEMENT) OPERATE IMHOFF SETTLING TANK

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [cleaning devices are simple tools] Forces acting on a body immersed or floating in a liquid [settling rates (Stokes Law)] Chemistry – use of lime to convert grease to soap and as an odor control agent Behavioral science (see appendix)	Whole numbers Use of numbers (without calculation) Counting

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Viewing Smelling		Terminology/general vocabulary Comprehension Memo format Describing (discrimination and verbalization of physical characteristics) Odors

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF IMHOFF TANK

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Standard operators tool kit Hose Brush Cleaning rod Grease gun Oil containers Boots Rainsuit Pencil and paper Operating report forms Maintenance report forms Lubrication Record cards Settling tanks Sludge and scum collector mechanisms Overflow weirs Baffles, sludge well, telescoping sludge valves, sludge withdraw line, and scum discharge system	Collect samples from influent and effluent per schedule Composite representative sample in proportion to flow Label and preserve samples per schedule Collect sludge samples per schedule when drawing sludge to sludge drying beds Transport samples to laboratory Observe other units in the plant for signs of malfunction of imhoff tank From the above tests and observations, make necessary adjustments to improve or maintain optimum plant performance Determine volatile solids content of sludge from draw off tube	Slipping on slippery surfaces – watch footing and clean up grease and oil Fall into tank No smoking in immediate area – methane gas Avoid breathing lime and handling lime with bare hands – lime dust – use dust mask, gloves, rubber apron

DECISIONS	CUES	ERRORS
Determine whether to initiate corrective action Determine whether to check sample collection and storage methods Determine whether to initiate corrective action, increase frequency of skimming, scraping down sludge, sludge draw off Determine when to withdraw sludge	Abnormal appearance, color, turbidity, solids carry over High or low results Solids carryover to biological oxidation system Sludge level high in digester or lower tank Low volatile content of digested sludge	Poor performance Non-representative samples Poor efficiency, increased load on subsequent plant units

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF IMHOFF TANK

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Chemistry – normality, conversion of units, standardization of solutions, oxidation-reduction reactions Biology, bacteriology – some knowledge of aquatic plants, animals, bacteria and molds, pathogens, fecal coliform Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition, subtraction, multiplication, and division algorithms, and order of operations, i.e., use of parentheses in simplifying arithmetic expressions [computing amount of composite sample] Basic arithmetic skills and concepts Ratio and proportion – estimation Changing mixed numbers to improper fractions [thermometer, graduated cylinder, pipettes] Measurement; geometric – Volume Measurement: non-geometric Time [date] Temperature

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening Viewing Touching Smelling		Terminology/general vocabulary Comprehension, process report – instructions Memo format, sample tags, forms, reports Auditory discrimination, and noise discrimination (recognize proper and improper sounds animal, human, and machines) Visual analysis, describing, detail and inference color discrimination, appearance of sample and units, reports Pressure Odor – recognize various types (pungent, aromatic, earthy, sour, etc.)

Duty H Performing Sludge Wasting and Digestion

1 Operate sludge wasting equipment and aerobic digester
2 Sample, analyze and evaluate performance of sludge wasting equipment and aerobic digester
3 Operate an anaerobic digester
4 Sample, analyze and evaluate performance of sludge wasting equipment and anaerobic digestive

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(TASK STATEMENT) OPERATE SLUDGE WASTING EQUIPMENT AND AEROBIC DIGESTER

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY -- HAZARD
Standard operators tool kit Hard hat, grease gun, "T" handle valve, wrench to fit waste valves Recording charts, grease, oil Waste sludge valves Waste sludge pumps Supernating valves Supernating pumps Digesting sludge Diffused air Air filters and blower snubbers Manometer and air flow meters Air supply valves Diffusers Motors Blowers Mechanical aeration Mechanical aerators Motors	Waste return sludge when instructed Record waste sludge flow meter readings Check/record manometer pressures Check/record air flow meter volume/change charts Adjust all valves and pumps as necessary Check lubrication for all equipment Check temperature on all pumps and motors Stop aeration -- withdraw supernatant Restart sludge digesting process at the end of supernating period Remove digested sludge when instructed Keep equipment clean	Poor footing -- falls -- keep floor and walkways clean and hand rails and guards in place and in good condition Electrical shocks -- wear and use proper safety equipment Burns from hot equipment -- wear and use proper safety equipment Muscle strains -- follow proper lifting procedure Head injuries

DECISIONS	CUES	ERRORS
Determine whether to follow instructions Determine whether to follow standard operating procedure Determine whether to follow standard under normal conditions -- shut down air supply unit and report to supervisor is unit fails to respond to normal adjustment procedure Determine whether to follow lubrication schedule and instructions Determine if unit is too hot -- shut down and report to supervisor -- unit too cold, no power -- check power supply Determine whether to close valves/restart, clean, and wipe all air supply units and filters	Instructions from supervisor Standard operating procedure Standard operating procedure -- abnormal operations, high/low readings Abnormal agitation in tanks Sight gages, high/low -- high temperature High or low temperature Instruction from supervisor Supernating process completed or sludge blanket pops to top of the tank Instruction from supervisor Dirty air filter, dust, dirt, and grease accumulation	Excess solids accumulation in aeration tanks Fail to maintain plant solids balance Result in rapid blower failure Insufficient air supply drop in digester efficiency Excessive wear and leakage Equipment failure Require excessive digester space or excess solids accumulate in aeration tanks Septic conditions and odor generation Overload digester tankage Insufficient air supply

(TASK STATEMENT) OPERATE SLUDGE WASTING EQUIPMENT AND AEROBIC DIGESTER

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Fluids under pressure [pump liquid slurries] Centrifugal forces developed by bodies in rotation [centrifugal pumps] Forces acting on a body immersed or floating in a liquid [sedimentation] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting, and coordinate system Fundamental operations (calculation) Addition and subtraction algorithms Basic measurement skills and concepts "Measure sense"/role of "unit" Instruments: Rate Measurement: geometric – volume Measurement: non-geometric – liquid and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – logs, and scale drawings/floor plans/blueprints

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, appropriate diction, enunciation, and clarity of expression
Reading		Comprehension, informational reports, physical experiment reports, process report–instruction
Writing		Penmanship, spelling, reports, and terminology general vocabulary
Listening		Auditory discrimination, noise discrimination
Viewing		Visual analysis, memory, color discrimination, and recognition of symbols, codes, emblems
Touching		Temperature – motion, pressure, torque
Smelling		Odor

(TASK STATEMENT)

SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF SLUDGE WASTING EQUIPMENT AND AEROBIC DIGESTER

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TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Two quart sampler on six-foot pole Sample jars – five hundred milliliters Routine plant sampling schedule Pencil and paper Digesting sludge supernatant	Collect samples of digesting, and digested sludge and supernatant for routing and special laboratory analysis Send samples to laboratory promptly Observe color and odor or turbidity of collected sample Record and report observations	Poor footing – falls Electrical shocks Burns from hot equipment Muscle strains Head injuries Keep floor and walkways clean and handrails and guards in place and in good condition Wear and use proper safety equipment Follow proper lifting procedures
DECISIONS	**CUES**	**ERRORS**
Determine whether to decide on completeness of digestion and supernating processes, and satisfactory settleability of digested sludge Determine whether to follow specified procedure Determine needed adjustment of air supply to digester tank	Routine plant sampling schedule or special sampling request Standard operating procedure Color of sludge or clarity of supernatant and presence of odor, i.e., visual – light brown/dark brown:insufficient air supply; smell – earthy/sour odor: solids concentration too high, digestion stopped on acid production, step–insufficient oxygen supply; smell – earthy/rotten egg: color – brown/black: insufficient air supply; visual and smell – supernatant highly colored – turbidity – foul odor–sludge held too long in digester–visual–supernatant – clear, little odor	Improperly digested sludge or too much sludge No laboratory results or invalid laboratory results, poor digester performance Poor digester results, anaerobic conditions – foul odors Poor plant operating data and equipment failures

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF SLUDGE WASTING EQUIPMENT AND AEROBIC DIGESTER

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage Fluids under pressure Centrifugal forces developed by bodies in rotation Simple chemistry of fermentation Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) Addition algorithm Subtraction algorithm Basic arithmetic skills and concepts Changing fractions to decimals and decimals to fractions Basic measurement skills and concepts "Measure sense"/role of "unit" Measurement: geometric – volume Measurement: non-geometric – time, and liquid

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading		Terminology/general vocabulary, enunciation Comprehension, informational reports, physical experiment reports, and process report – instructions
Writing Listening		Reports, and terminology/general vocabulary Auditory discrimination, concentration, and noise discrimination (recognize proper and improper sounds; animal, human, machine)
Viewing		Visual analysis (seeing the parts in relation to the whole), memory (short and long term retention), recognition of symbols, codes, and emblems
Smelling		

(TASK STATEMENT) OPERATE AN ANAEROBIC DIGESTER

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Standard operator's tool kit Hoses, broom, squeegee, explosimeter Hard hat and safety goggles Manuals, bench sheets Valves Motors Pumps Manometers Thermometers Gas meters (cubic feet) Heat exchangers, boiler Waste gas burner and pilot light Digester tank and cover Digester sludge mixing equipment Condensation traps Sludge	Become familiar with proper sequence of valve settings needed to properly operate the anaerobic digester system Draw raw sludge from primary clarifier and send to primary sludge digester Check primary digester sludge recirculation equipment, digester, heat exchanger, and record temperature Check water sight gauge Withdraw primary and secondary supernatant and record amount Transfer sludge from primary to secondary digester and record amount Withdraw digester sludge from secondary digester and send to disposal system Observe, record, and report manometer pressures, and gas production recordings Empty condensation traps according to schedule and check operation of sludge gas waster burner	Safe footing Personal hygiene Explosions Hard hats No flames, sparks Good ventilation Frequent checking of water sight gauges Never breathe digester gas

DECISIONS	CUES	ERRORS
Determine how to read, understand, and follow proper valve setting sequence Determine whether to follow posted withdrawal schedule or to adjust schedule, when necessary, to achieve optimum digester operation; report necessary deviations from schedule to supervision Determine whether to make normal operator adjustments and report failure to supervision Determine whether to withdraw only sufficient supernatant to provide room for incoming sludge (continued)	Knowledge of possible damage to equipment, digestion process, and ever-present danger of formation of explosive conditions inherent in anaerobic digestion process Posted raw sludge withdrawing schedule or consistency of raw sludge samples, or a rapid drop in sludge gas production and/or drop in primary digester pH Drop in gas production, pH or digester temperature; low or falling digester temperature Supernatant withdrawal schedule Accumulation of excess solids in primary supernatant or in bottom of digester (continued)	Sending sludge to wrong unit, or allowing digester to drain back through raw sludge pump to wet well; this may allow air to be drawn into digester causing an explosive environment Stuck digester – poor quality gas Too little supernatant – lack of space for incoming sludge causing overflow Too much supernatant – introduction of air to digester causing explosive condition Loss in capacity of digester producing excess solids in supernatant – organic overload on plant process (continued)

(TASK STATEMENT) OPERATE AN ANAEROBIC DIGESTER, CONTINUED

DECISIONS	CUES	ERRORS
Determine whether to have supernatant analyzed for solids content and sample digester for solids accumulation level – transfer sludge as needed to maintain optimum conditions Determine how to read measuring devices accurately and promptly Determine whether to drain completely Determine if there is sufficient gas pressure to operate waste gas burner, and if pilot light is lit	Accumulation of excess solids in secondary supernatant or solids level in digester Reporting instruction (SOP) Level in sight gauges on condensation traps No flame on waste gas burner	High pressure causes safety valve to shut off digester gas and swithc to commercial fuel Higher pressure will open relief valve, causing explosive condition Low pressure – same problems as with high pressure Water in gas collection system will cause diaphragm valve, metering equipment, and gas-using equipment failure; pipe corrosion; waste gas burner will not operate Gas escapes from pressure/vacuum relief valve creating explosive conditon

(TASK STATEMENT) OPERATE AN ANAEROBIC DIGESTER

SCIENCE	MATH — NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Fluids under pressure [floating tank cover] Centrifugal forces developed by bodies in rotation [centrifugal pumps Forces acting on a body immersed or floating in a liquid [sludge settling] Transfer of heat from one body to another [heat exchanger] Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) — addition and subtraction algorithms Basic measurement skills and concepts "Measure sense"/role of "unit" Instruments: Rate Measurement: geometric — linear, area, and volume Measurement: non-geometric — time, temperature, weight, liquid and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs — scale drawings/floor plans/blueprints Basic geometry skills and concepts Determination of area and volume of rectangular, cube, and right triangular prisms; of cylinders; of altitude, area, and volume of a right circular cone; of the surface and volume of a sphere Basic logic — deductive or inductive Implications/converse/inverse/contrapositive

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, enunciation, clarity of expression, and logic
Reading		Comprehension, informational reports, physical experience reports, description of mechanism, terminology, process report (instructions)
Writing		Penmanship, spelling, reports, terminology/general vocabulary, clairty of expression, logic
Listening		Auditory discrimination, discriminate facts from non-facts, recognize opinions, concentration, logic, noise discrimination
Viewing		Visual analysis, memory, describing, logic, detail and inference, color discrimination
Touching		Size, shape, consistency, temperature, texture, motion, torque

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF AN ANAEROBIC DIGESTER

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Standard operators tool kit Hard hats Explosimeter Sludge gas sampler Digester depth sampler Sampling schedule Eye protection – goggles, washing Two quart containers for sludge samples Simplified carbon dioxide gas analysis equipment Thermometer Reporting form Pencil Potassium hydroxide (carbon dioxide analysis) Sludge (raw, digested) Supernatant Sludge gas Sampling valves	Collect composite raw sludge sample Take temperature immediately Note any appearance abnormalities in sample Send sample to laboratory for SOP analysis Collect composite digested sludge sample Collect sludge gas sample, and send to laboratory for standard plant analysis Optional: collect and perform simplified carbon dioxide sludge gas content analysis	Safe footing Personal hygiene Explosions Head injuries Never breathe digester gas Safety goggles Eye wash kit

DECISIONS	CUES	ERRORS
Determine whether to follow schedule under routine conditions Determine whether to take needed sample to determine corrective operating procedure to restore normal gas production	Sampling schedule under routine operating conditions Sudden drop in gas production	Inability to evaluate normal performance of digester and recognize potential digester process failure Unnecessary digester process failure

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF AN ANAEROBIC DIGESTER

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Fluids under pressure [pipe line pressures] Forces acting on a body immersed or floating in a liquid [sludge settling] Transfer of heat from one body to another [heat exchanger] Sampling technique Caustic nature of strong alkaline (KOH) Simple gas diffusion Behavioral science (see appendix)	Hindu-Arabic numeral system: number/numeral, place value/expanded notation Positive rational numbers Fundamental operations (calculation) – addition, subtraction, multiplication, and division algorithms Basic arithmetic skills and concepts: reduction of fractions; changing mixed numbers to improper fractions; changing percents to fractions and vice versa; finding a percent of a number and vice versa; changing fractions to decimals and vice versa; ratio and proportion; estimation; rounding off decimals and whole numbers Use of computing devices and mechanical aids: slide rule; calculators – electric Basic measurement skills and concepts: "measure sense"/role of "unit"; rate; instruments: measurement: geometric – volume; measurement: non-geometric – time, temperature, weight, liquid; read and interpret tables, charts, and graphs: scale drawings/floor plans/blueprints Basic logic: deductive/inductive; implications/converse/inverse

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, enunciation clarity of expression, logic
Reading		Comprehension, informational reports, physical experience reports, description of mechanism, terminology, process report – instructions
Writing		Penmanship, spelling, reports, terminology/ general vocabulary, clarity of expression, logic
Listening		Auditory discrimination, noise discrimination
Touching		Size, shape, depth, consistency, temperature, texture, movement
Smelling		

Duty I Performing Biological Decomposition Via Activated Sludge Processes (Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

1. Operate activated sludge processes via diffused air/positive displacement blower
2. Operate activated sludge processes via diffused air/centrifugal blower
3. Operate activated sludge processes via mechanical aeration/fixed or floating
4. Sample, analyze, and evaluate performance of activated sludge processes

(TASK STATEMENT) OPERATE ACTIVATED SLUDGE PROCESSES VIA DIFFUSED AIR/POSITIVE DISPLACEMENT BLOWER
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Filter Snubber Manometer/air flow meter Main air supply control valve Aeration rate adjustment valve Diffusers – hand/self-cleaned Blower motor Blower Return sludge valve/or telescope valve Return sludge pumps (fixed/variable speed) Recorder charts Oil and oil can Grease and grease gun (all valves, motor, and pumps) Pencil and paper Hard hat Rainsuit and boots T-handle wrench ARA wrench	Observe operation – all equipment Record pressure on manometer, and change chart on A.F.M. Adjust all valves and pumps as necessary Check oil and temperature level on blower motor Check oil and grease on valves, motor, and pumps Report and record results Check temperature of air discharge header at each blower Compare high temperature limit with manufacturer's specifications	Hand railings Life preservers and hooks Skid-proof footing First aid kit Fire extinguisher Oxygen deficiency practices Falling in Noxious fumes Slippery footing Infectious diseases Head and body injury Electrical/fire motor

DECISIONS	CUES	ERRORS
Determine whether to clean or replace element high/low pressure/airflow; clean diffuser filters and snubber; check fir air leaks in system Determine whether to lubricate Determine whether diffusers or lines are plugged Determine whether to check blower; check flow meter; check amperage Determine if air leak is present in line, or check for plugged line or if valve is too high above water line level Determine whether to clean it, check discharge valve – make sure it is clean and check power supply to pump	Proper operation of equipment Dirt and dust accumulation Noise volume Pressure level (high or low) Hard to turn Bubble roll appearance Excessive heat Oil and temperature levels (high or low) Either hardness of turning, low/high return rate, free flowing, and hardness of turning Rate of flow, plugged	Process failure due to insufficient air Over-heating and failure of blower unit; Too much/too little air supply Motor failure (shut off, report to supervisor) Blower failure (shut off, report to supervisor) Too much/too little sludge Kick out, over-heat, too much/too little sludge

(TASK STATEMENT) OPERATE ACTIVATED SLUDGE PROCESSES VIA DIFFUSED AIR/POSITIVE DISPLACEMENT BLOWER
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Forces acting on a body immersed or floating in a liquid [pumps] Transfer of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps, valves] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, and valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening Viewing Touching Smelling		Terminology/general vocabulary, logic, and usage Comprehension, informational reports, recommendation reports, progress reports Memo format, description, reports, terminology/general vocabulary, clarity of expression, and logic Noise discrimination (recognize proper and improper sounds; animal, human, machine) Visual analysis (seeing the parts in relation to the whole), logic (ordering of thoughts) Temperature Fire, and septic odor

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(TASK STATEMENT) OPERATE ACTIVATED SLUDGE PROCESSES VIA DIFFUSED AIR/CENTRIFUGAL BLOWER
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Blower motor, amp meter Air intake/discharge valve on blower Filter Main air supply control valve Aeration rate adjustment valve Diffusers – hand/self cleaned Blower motor Blower Return sludge valve/or telescope valve Return sludge pumps (fixed/variable speed) Recorder charts Oil and oil can Grease and grease gun (all valves, motor, pumps) Pencil and paper Hard hat Rain suit and boots T-handle wrench ARA wrench	Observe operation – all equipment Adjust all valves and pumps as necessary Check oil and temperature level on blower motor Check oil and grease on valves, motor, pumps Report and record results Check amp meter (high and low) Check air temperature at each blower on air discharge header Compare high temperature limit with manufacturer's specifications	Hand railings Life preservers and hooks Skid-proof footing First aid kit Fire extinguisher Oxygen deficiency practices Falling in Noxious fumes Slippery footing Infectious diseases Head and body injury Electrical/fire motor

DECISIONS	CUES	ERRORS
Determine whether to clean or replace element high/low pressure/airflow, clean diffuser filters and snubber, or check for air leaks in system Determine whether to lubricate it High amp – check for line restriction on discharge Low amp – check for line restriction on inlet, or plugged filter Determine whether diffusers or lines are plugged Determine whether to clean it, check discharge valve for cleanliness and check power supply to pump; check blower, flow meter, amperage Determine whether air leak is present in line, or line is plugged, or valve is too high above the water line level	Proper operation of equipment Pressure level (high or low) Hard to turn Bubble roll appearance Excessive heat Amp meter (high or low) Oil and temperature levels (high or low) Either hardness of turning, low/high return rate, free-flowing, and hardness of turn	Too much/too little air supply Motor failure (shut off and report to supervisor) High amperage indicates excessive load on blower and results in blower failure; low amperage – surging – insufficient air supply, blower failure, and process failure Blower failure (shut off and report to supervisor) Too much/too little sludge Kick out, overheating, too much/too little sludge

(TASK STATEMENT) OPERATE ACTIVATED SLUDGE PROCESSES VIA DIFFUSED AIR/CENTRIFUGAL BLOWER
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Forces acting on a body immersed or floating in a liquid [pumps] Transfer of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps, valves] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapostive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, logic, usage
Reading		Comprehension, informational report, recommendation reports, progress reports
Writing		Memo format, description, reports, terminology and general vocabulary, clarity of expression, logic
Listening		Noise discrimination (recognize proper and improper sounds: animal, human, machine)
Viewing		Visual analysis, logic
Touching		Temperature
Smelling		Fire and septic odor

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(TASK STATEMENT) OPERATE ACTIVATED SLUDGE PROCESSES VIA MECHANICAL AERATION/FIXED OR FLOATING
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Grease gun Oil can Grease Oil Pencil and paper Hard hats Rain suit Common to both types: Aerator Return sludge valve, or return sludge telescope valve Return sludge pumps (fixed/variable speed) Flow weir (effluent) Fixed Oil sight glass Floating only Power cable for aerator Mooring cables for aerator	Observe operation of all equipment Check motor (oil and temperature) Check surface agitation pattern Check cables (mooring, power – for floating system only) Check oil and grease on valves, and pumps Check oil in aerators for evidence of water	Hand railings Life preservers and hooks Skid proof footing First aid kit Fire extinguisher Oxygen deficiency practices Falling in Noxious fumes Slippery footing Infectious diseases Head and body injury Electrical/fire motor Suspend above water Electrocution by the power line in the water

DECISIONS	CUES	ERRORS
Determine whether to add oil; requires maintenance – report unusual spray patterns conditions Determine whether to grease; find air leak in line Determine whether to grease; check for plugged line or valve too high above water level Determine whether to clean it, and check discharge valve, and make level Determine whether to suspend power cable above water – tighten cables, or replace	Aerator; oil – low, temperature – high, level water spray patterns Difficulty of turning, low return rate Difficulty of turning; free flowing Rate of flow; plugged Evenness of flow over weir Sagging power cable in water Mooring cables are tight Frayed or sagging Water visible as soon as oil drain cock is opened	Over-heating – failure of unit Too much/too little sludge introduced in system Kick out, over-heat, too much/too little sludge Short-circuiting; improper detention and flow velocity Potential electrocution Mixing will be short circuited

(TASK STATEMENT) **OPERATE ACTIVATED SLUDGE PROCESSES VIA MECHANICAL AERATION/FIXED OR FLOATING**
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Forces acting on a body immersed or floating in a liquid [pumps] Transfer of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps, valves] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, and valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening Viewing Touching Smelling		Terminology/general vocabulary, logic, and usage Comprehension, informational reports, recommendation reprots, progress reports Memo format, description, reports, terminology/general vocabulary, clarity of expression, and logic Noise discrimination (recognize proper and improper sounds; animal, human, machine) Visual analysis (seeing the parts in relation to the whole), logic (ordering of thoughts) Temperature Fire, and septic odor

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(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF ACTIVATED SLUDGE PROCESSES
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Watch or thirty-minute timer Wastewater Two-quart dipper on six foot pole One-thousand milliliter graduated cylinder Sample jars (five hundred milliliters) Hard hat Rain suit Routine plant sampling schedule Pencil and paper	Collect dissolved oxygen and suspended solids, grab samples at the aeration (reaeration) tank effluent, and send to the laboratory Collect settleable solids, grab sample at the aeration tank effluent, and conduct settling test immediately on site, and report and record results Observe the color of the samples collected, and report and record results Test dissolved oxygen immediately on site	Hand railings Life preservers and hooks Skid proof footing First aid kit Fire extinguisher Oxygen deficiency practices Falling in Noxious fumes Slippery footing Infectious diseases Head and body injury Electrical /fire motor

DECISIONS	CUES	ERRORS
Decide acceptability of the settleability of the activate sludge, and report and record the results From the color determination: Influent color – dark –septic , light – normal, unusual – special waste Effluent color – dark – too much activated sludge, light – not enouch activated sludge Tank color – gray to brown – possible oxygen deficiency	Routine plant sampling schedule Operator reports Color of mixed liquor in aeration tank	Insufficient aeration – kill aerobic bacteria; reduce treatment efficiency Too much/too little activated sludge – reduces treatment efficiency Unacceptable settleability of activated sludge – poor secondary clarification

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF ACTIVATED SLUDGE PROCESSES
(To Include: Contact Stabilization, Step Aeration, Conventional Activated Sludge, and Extended Aeration)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [dipper] Forces acting on a body immersed or floating in a liquid [settleable solids] [Color perception] Behavioral science (see appendix)	Set of real numbers Whole numbers Fundamental operations (Calculation) Use of numbers (without calculation) Counting Basic measurement skills and concepts: Measurement: non-geometric – time, and liquid Basic logic: Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, clarity of expression, logic, and usage
Reading		Comprehension, informational reports, recommendation reports, progress reports, physical experiment reports, and terminology
Writing		Memo format, description, reports, terminology, general vocabulary, clarity of expression, and logic
Viewing		Visual analysis (seeing the parts in relation to the whole), describing (discrimination and verbalization of physical characteristics), and color discrimination
Smelling		Septic odor

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Duty J Performing Biological Decomposition Via Trickling Filters

1 Operate high and low rate trickling filters
2 Sample, analyze, evaluate performance of trickling filters

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Cleaning hook Nozzle removing tool Standard operators tool kit Pipe wrenches Hose Rake Shovel Pick Spud bar Oil and grease Primary trickling filter Secondary trickling filter Recirculation pumps Distributor system – rotary and fixed nozzle Dosing tank (automatic syphon) Valves	Inspect equipment for proper operation Observe spray pattern from nozzles Lubricate equipment Clean nozzles Make minor repairs Order maintenance repairs Make control changes for best plant performance Report and record results and process changes	Slipping – filter very slippery due to biological growth Pinching – rotating distributor arm, recirculating pumps – never attempt to stop a moving distributor by hand

DECISIONS	CUES	ERRORS
Determine whether to flush out arms, level arms, check bearings Determine whether to write maintenance order to clean mercury and replace lost mercury Determine whether to clean, check for solids overflow from primary Determine whether to check ventilation, increase recirculation rate, keep wastewater splash away from exposed structures Determine whether to increase recirculation, apply insecticides, apply chlorine, provide good ground maintenance and clean-up practices (continued on the next page)	Rough or vibration of distributor arms Leakage past mercury seal Plugged orifices Odors, filter flies, ponding Operating reports, textbooks, training manuals, laboratory reports Rotation speed abnormal Heavy sloughing from filters Icing on walls or distributor Poor growth on filter media Change in characteristics of growth on media – color, volume, variety of organisms	If improper – low treatment efficiency, odors Poor treatment

TASK STATEMENT) OPERATE HIGH AND LOW RATE TRICKLING FILTERS, CONTINUED

DECISIONS	CUES	ERRORS
Determine whether to flush filter surface with high pressure water stream, remove debris from surface, apply chlorine, remove from service to allow growth to dry, check media for weathering Determine whether to check oil and bearings, check orifices Determine whether it is due to temperature change or to toxic wastes Determine whether to reduce spray by changing orifices, reduce amount of recirculation, operate two-stage filters in parallel, rather than in series, break up ice, and remove Determine whether to check for excessive hydraulic loads, organic shock loads, toxic wastes Determine whether to change recirculation rate, get samples for toxic wastes analysis Determine whether to change recirculation rate, change from parallel to series operation, change detention time in final settling tank		

(TASK STATEMENT) OPERATE HIGH AND LOW RATE TRICKLING FILTERS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Work input, work output, friction and efficiency in simple machines [distributor arm] Effect of heating and cooling on state of matter (change of matter from one form to another) [icing, evaporation] Inertia and momentum (body at rest and body in motion) [stopping or starting distributor] Biological – types of growth on trickling filter media Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) – recirculations Basic arithmetic skills and concepts: Ratio and proportion; estimation – recirculations Basic measurement skills and concepts: Instruments: temperature ; rate [pumping, recirculation, r.p.m. of distributor Measurement: non-geometric – temperature, weight, speed (example: feet per minute, R.P.M., etc.) [hydraulic loading distributor] Read and interpret tables, charts, and graphs – scale drawing. Basic algebra skills and concepts: use of variables – in formulae, and parameters ; manipulation of formulae Basic geometry skills and concepts: Knowledge of geometric relationships – parallel, and perpendicular [leveling distributor]

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary
Reading		Comprehension, description of mechanism, and process report – instructions
Writing	Work orders, operating reports	Memo format
Listening		Auditory discrimination, and noise discrimination (recognize proper and improper sounds: animal, human, and machine)
Viewing		Visual analysis (seeing the parts in relation to the whole), describing (discrimination and verbalization of physical characteristics), and color discrimination
Touching		Motion-vibration, pressure–valve closing
Smelling		Type of odor

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF TRICKLING FILTERS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY — HAZARD
Sampling dipper Thermometer Sample containers Graduated cylinder D.O. sampler Sterile bacterial bottle Raincoat Refrigerator Automatic sampler D.O. glassware D.O. reagents Influent to and effluent from trickling filter	Sample influent and effluent per schedule Measure and record temperature and D.O. per schedule Composite representative sample in proportion to flow Label and preserve samples per schedule Run thirty minute settling test on trickling filter effluent, and record results (on site) Transport samples to laboratory Observe other units in plant for signs of mal function From the above tests and observations, make the necessary adjustments on equipment to improve or maintain optimum plant performance	Slipping — filter very slippery due to biological growth Pinching — rotating distributor arm, recirculating pumps; never attempt to stop a moving distributor by hand

DECISIONS	CUES	ERRORS
Determine whether to initiate corrective action — adjust recirculation ratio, adjust organic and hydraulic loading Determine whether to check sampling method Determine cause — temperature, shock load, or toxic materials	Abnormal appearance, turbidity, color, visible biological activity, odor, suspended solids High or low results Excessive suspended solids Little or no suspended solids	Poor treatment efficiency Non-representative samples Destruction of biological life on filter media

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF TRICKLING FILTERS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [simple tools] Chemistry – normality, conversion of units, standardization of solutions, oxidation-reduction reactions Biology, bacteriology – some knowledge of aquatic plants, animals, bacteria and molds, pathogens, fecal coliform Behavioral science (see appendix)	Positive rational numbers Fundamental operations (calculation) – addition, subtraction, multiplication, and division algorithms, and order of operations (computing amount of composite sample) Basic arithmetic skills and concepts – Ratio and proportion–estimation Changing mixed numbers to improper fractions Basic measurement skills and concepts – Instruments: thermometer, graduated cylinder, pipettes Measurement: geometric – volume Measurement: non-geometric – time (date) , temperature

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Listening	Sample tags, forms, reports	Terminology/general vocabulary Comprehension, process report – instructions Memo format Auditory discrimination, and noise discrimination (recognize proper and improper sounds: animal, human, and machine)
Viewing	Appearance of sample and units, reports	Visual analysis (seeing the parts in relation to the whole), describing (discrimination and verbalization of physical characteristics), detail and inference, and color discrimination
Smelling		Odor – recognize various types (pungent, aromatic, earthy, sour, etc.)

Duty K Performing Biological Decomposition Via Oxidation Lagoons/Ponds (Facultative, Aerobic, and Anaerobic)

1 Operate oxidation ponds/lagoons for secondary treatment
2 Sample, analyze, and evaluate performance of oxidation ponds/lagoons for secondary treatment

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OPERATE OXIDATION PONDS/LAGOONS FOR SECONDARY TREATMENT

(TASK STATEMENT) (To Include: Aerated—Facultative, and Strictly Aerobic and Anaerobic Ponds/Lagoons)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD 73
Filter, snubber, manometer, air flow meter, main air supply control valve, aeration rate adjustment valve, diffusers – hand/self cleaned, blower motor, blower Blower motor amperage meter, air intake/discharge valve on blower T-handle wrench, ARA wrench, oil can, grease gun Recorder charts, oil, grease, pencil and paper, hard hats, rain suit, and boots Aerator, flow weir (effluent), oil sight glass, power cable for aerator, mooring cables for aerator Rake, shovel, measuring stick, boat, life preservers, hand skimming device, bucket, boots Influent and effluent locations, waste water, scum and debris, levee material, and sludge deposits	Aerated lagoons: Observe operation/flow velocities, weirs Check for scum and debris, and remove Check integrity of banks/levees for infiltration and exfiltration Check for sludge deposition and measure accumulation Report and record results Adjust all valves and pumps as necessary	Hand railings Life preservers and hooks Skid proof footing First aid kit Fire extinguisher Oxygen deficiency practices Noxious fumes Slippery footing Infectious diseases Head and body injury Electrical/fire motor Suspend above water Electrocution by the power line in the water

DECISIONS	CUES	ERRORS
Determine whether to: clean or replace elements; high/low pressure/air flow – clean diffusers, filters, and snubber, or check for air leaks in system; lubricate it; ascertain whether diffusers or lines are plugged; check flow meter; check blower; check amperage Determine whether to: make level; adjust to proper level or/too low – take out of service, to high – put additional units into service Determine if bubbles indicate: high/low – influent flow velocities, high – scouring or low nitrification (continued)	Evenness of flow over influent and effluent weirs (if used) Flow velocities – too high/too low Unusual bubble formation not produced by aeration, and odor Floating scum, debris, sludge, algae Erosion, leakage, weeds Increased elevation of pond bottom Determine proper operation of equipment Determine proper dirt and dust accumulation Determine proper noise volume Determine pressure level (high or low) Hard to turn (continued)	Reduce treatment efficiency Scouring, nitrification, and lower treatment efficiency Odor – go septic, reduce treatment efficiency complaints Leakage in or out; loss of levee insect breeding sites Short-circuiting, treatment reduction Process failure due to insufficient air Overheating and failure of blower unit Too much/too little – air supply Motor failure (shut off, and report to supervisor) (continued)

TASK STATEMENT) OPERATE OXIDATION PONDS/LAGOONS FOR SECONDARY TREATMENT, CONTINUED
(To Include: Aerated--Facultative, and Strictly Aerobic and Anaerobic Ponds/Lagoons)

DECISIONS	CUES	ERRORS
Determine if odor is due to septic conditions caused by: scum algal bloom and death, inefficient aeration, organic over/under loading Determine whether to break up or remove Determine whether to patch, fix or remove Determine whether to seriously short-circuit the treatment process	Bubble roll appearance Excessive heat Oil and temperature levels (low or high)	Blower failure (shut off and report to supervisor) Too much/too little sludge Kick out, over-heat sludge

(TASK STATEMENT) OPERATE OXIDATION PONDS/LAGOONS FOR SECONDARY TREATMENT
(To Include: Aerated–Facultative, and Strictly Aerobic and Anaerobic Ponds/Lagoons)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Forces acting on a body immersed or floating in a liquid [pumps] Transfer of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, and valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, logic, and usage
Reading		Comprehension, informational reports, recommendation reports, progress reports
Writing		Memo format, description, reports terminology/general vocabulary, clarity of expression, and logic
Listening		Noise discrimination (recognize proper and improper sounds; animal, human, and machine)
Viewing		Visual analysis (seeing the parts in relation to the whole), logic (ordering of thoughts)
Touching		Temperature
Smelling		Fire, and septic odor

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF OXIDATION PONDS/LAGOONS FOR SECONDARY TREATMENT (To Include: Aerated—Facultative, and Strictly Aerobic and Anaerobic Ponds/Lagoons)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY — HAZARD
Wastewater Thermometer pH color comparator Two-quart dipper on six foot pole Sample jars (500 milliliters) Hard hat Rain suit Routine plant sampling schedule Pencil and paper	Collect the following samples and send to lab: Dissolved oxygen — effluent — grab BOD —influent and effluent — composite Coliform Bacteria — effluent — grab Suspended Solids — influent — grab Suspended Solids — effluent — grab Dissolved Solids — influent — grab Dissolved Solids — effluent — grab Collect samples and run the pH and temperature tests on site and report and record the results Observe color of wastewater throughout pond; report and record results	Hand railings Life preservers and hooks Skid proof footing First aid kit Fire extinguisher Oxygen deficiency practices Falling in Noxious fumes Slippery footing Infectious diseases Head and body injury Electrical/fire motor Suspend above water Electrocution from the power line in the water Safe boating practices Boating hazards (drowning, etc.)

DECISIONS	CUES	ERRORS
Determine if the pH range is too high/low — higher the temperature —more aeration required Determine if color is due to: Algal bloom Industrial waste Septic conditions Pond upsets (seasonal turnovers)	Routine plant sampling schedule Operator reports Color of mixed liquor in pond	High/low pH will slow down activity or kill active bacteria If temperature is too high and aeration (oxygen transfer) is not sufficient, the bacteria will slow down and die Algal bloom will block aerobic decomposition Industrial waste may shock bacteria and slow or kill them Insufficient oxygen will kill aerobic bacteria; cause objectionable odors Insufficient treatment

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF OXIDATION PONDS/LAGOONS FOR SECONDARY TREATMENT (To Include: Aerated—Facultative, and Strictly Aerobic and Anaerobic Ponds/Lagoons)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [dipper] Forces acting on a body immersed or floating in a liquid [settleable solids] [Color perception] Behavioral science (see appendix)	Set of real numbers Whole numbers Use of numbers (without calculation) Counting Basic measurement skills and concepts: Measurement: non-geometric – time, and liquid Basic logic: Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, clarity of expression, logic, and usage
Reading		Comprehension, informational reports, recommendation reports, progress reports, physical experiment reports, and terminology
Writing		Memo format, description, reports, terminology/general vocabulary, clarity of expression, and logic
Viewing		Visual analysis (seeing the parts in relation to the whole), describing (discrimination and verbalization of physical characteristics), and color discrimination
Smelling		Septic odor

Duty L Performing Chlorination

1 Operate pre and post treatment chlorinating systems
2 Sampling, analyzing, and evaluate performance of pre and post treatment chlorinating system

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(TASK STATEMENT) OPERATE PRE AND POST TREATMENT CHLORINATING SYSTEMS (To Include: Liquid and Gas Treatment)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Hard hats, ammonia tester, safety shoes, air pac, color comparator, water sampler, gas mask Recorder chart, paper and pencil, and lead washers Valve and nut wrench Chlorine container, scales, cradles, hoist and lifting clamp, connector tubing (whips), chlorine recorder, valves (shut-off, relief, check, safety, gas, liquid), pressure gages, feeders (vacuum, partial vacuum, pressure, and pulsating), exhaust fans, safety equipment, control equipment, evaporator (for liquid ammonia withdrawal), mixing chamber (for hypochlorite solution), diffusers, contact chamber, and thermometer Ammonia storage containers Ammonia feed system Chlorine containers – cylinders or ton containers	Turn on exhaust fan and check for presence of chlorine with ammonia (white cloud formation), or by smell Observe operation – inspect all equipment and contact chamber Record pressure, weight, chlorine residuals, and flow rates Replenish chlorine supply if necessary, and check system for leaks Adjust valves, feeders, and control equipment as necessary Report and record results Collect wastewater samples from plant influent and plant effluent for chlorine residual and coliform determinations Test samples immediately for chlorine residuals (on site) Record and report results Check for floating debris and sludge deposits Take sample to laboratory for the coliform test	Air pack, gas cannister, exhaust fans – oxygen deficiency practices Hard hat, and safety shoes Fire extinguisher First aid kit Proper team rescue operations and notification procedures Training in proper ammonia handling procedures Ammonia container repair procedures Noxious fumes Head and body injury Electrical/fire motor Ammonia burns Contamination of clothes with ammonia
DECISIONS	**CUES**	**ERRORS**
Determine whether to send back if overweight; call safety alert Determine whether to report if not operational Determine whether to take out of operation and have repaired Determine whether to replace with new tube, and lead washer; and report; see if chlorine flow is too great Determine whether recorder or system is malfunctioning Determine if gage or system is malfunctioning Determine if feeder or system is malfunctioning	Check for overweight, leaks Operational Cracks, splinters Creaking, working hard Discoloration (turns green), iced Abnormal readings; too high/too low Malfunctions – leakage On the floor, exits outside, switches on outside of the chlorine room; blades face proper direction Cannisters not out of date; rubber mask fits, and is not cracked; air pac is full	Insufficient disinfection, under or over feeding Major safety hazard which may result in death of the operator Broken valve stem on chlorine cylinder or ton container. Total loss of chlorine

OPERATE PRE AND POST TREATMENT CHLORINATING SYSTEMS
(To Include: Liquid and Gas Treatment), CONTINUED

(TASK STATEMENT)

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Chlorine feed system a) gas feed chlorinator b) liquid feed vaporizor	Observe operation of chlorine feed system, note rate of chlorine application and adjust for proper dosing application	

DECISIONS	CUES	ERRORS
Determine if it is operating adequately Determine whether to unplug Determine whether to clean out Determine whether to shut it off if temperature is too low, and repair	Malfunctions – leakage, hard to turn, plugged lines, signs of corrosion Leakage, malfunction in stirring mechanism Plugged Bubbles, sludge deposition, short circuiting Below 50 degrees, Fahrenheit in the chlorine room Cracked packing, hardness of turning, and leakages	

(TASK STATEMENT) OPERATE PRE AND POST TREATMENT CHLORINATING SYSTEMS (To Include: Liquid and Gas Treatment)

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Forces acting on a body immersed or floating in a liquid [pumps] Transfer of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps, valves] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, and valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking		Terminology/general vocabulary, logic, and usage
Reading		Comprehension, informational reports, recommendation reports, progress reports
Writing		Memo format, description, reports, terminology/general vocabulary, clarity of expression, and logic
Viewing		Visual analysis (seeing the parts in relation to the whole), logic (ordering of thoughts)
Touching		Temperature
Smelling		Fire and septic odor
Listening		Noise discrimination

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF PRE AND POST CHLORINATING SYSTEMS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Six-foot pole with a quart container Wastewater Color compartor Hard hat Rain suit Rubber boots 125 ml. sterilized jars with 0.1 ml. sodium thiosulfate in them Orthotolidine Pencil and paper Arsenite solution Routine plant sampling schedule Ammonia and residual chlorine Color slides (0 – 2 mg/l) orange	Collect sample from outlet of ammonia tank for residual and for coliform determinations Test sample for ammonia residual on site immediately Record and report results Check for floating debris and sludge deposits Take samples to laboratory for coliform test	Air pack, gas cannister, exhaust fans – oxygen deficiency practices Hard hat, and safety shoes Fire extinguisher First aid kit Proper team rescue operations and notification procedures Training in proper ammonia handling procedure Ammonia container repair procedures Noxious fumes Head and body injury Electrical/fire motor Ammonia burns Contamination of clothes with ammonia

DECISIONS	CUES	ERRORS
Decide acceptability of chlorine residual, floating debris, and sludge deposition, and report and record results	Routine plant sampling schedule Sight-floating debris Smell – odor of ammonia Operators reports	Insufficient treatment and excess material leaving in effluent Insufficient chlorination or excess ammonia used Feed rate set too high

(TASK STATEMENT) SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF PRE AND POST CHLORINATING SYSTEMS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Forces acting on a body immersed or floating in a liquid [pumps] Transfer of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps, valves] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, and valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Viewing Touching Smelling Listening		Terminology/general vocabulary. logic, and usage Comprehension, informational reports, recommendation reports, progress reports Memo format, description, reports, terminology, general vocabulary, clarity of expression, and logic Visual analysis (seeing the parts in relation to the whole), logic (ordering of thoughts) Temperature Fire and septic odor Noise discrimination

Duty M Performing Outfall Evaluation

1 Operate, maintain and sample, analyze and evaluate performance of sewage treatment plant outfalls

(TASK STATEMENT) OPERATE, MAINTAIN, SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF SEWAGE TREATMENT PLANT OUTFALLS

TOOLS, EQUIPMENT, MATERIALS, OBJECTS ACTED UPON	PERFORMANCE KNOWLEDGE	SAFETY – HAZARD
Wastewater Backwater gate Headwall Pipeline Pencil and paper Routine plant sampling schedule Boat Life preserver Sterile sampling jars (125 ml. with 0.1 ml. sodium thiosulfate) Ammonia color comparator kit Standard operators tool kit Six-foot pole with a quart container	Observe the backwater gate, headwall and pipeline for physical malfunction and failure; and repair as necessary Check for: Sludge deposition, foaming, floating debris, grease and oil (leaving outfall), and color Collect samples for chlorine residual and coliform bacteria determination Test sample for ammonia residual on site immediately Record and report results Take samples to laboratory for coliform bacteria determination	Safe boating practices First aid kit Life preservers Falling into the water Slippery footing Head and body injury Boating hazards

DECISIONS	CUES	ERRORS
Determine whether the physical treatment processes are functioning with respect to foam, sludge, floating debris, grease and oil, and color/or is there infiltration into effluent line Determine mode of clean-up for above properties and whether clean-up is necessary Decide whether there is excessive water pressure on backwater gate Determine whether headwall stability and anchorage is sufficient, and if not, ascertain method of repair Determine integrity of pipeline	Accumulation of sludge near site Foaming present Floating debris is present Grease and oil is present Effluent is of a unusual color Gate hinge does not work Headwall is cracked, spaulded, or eroded away from bank Pipeline is cracked, broken, or corroded	Adversely effects the water quality of the effluently receiving water body and may result in a pollution citation if serious enough Receiving body water will back up into the plant if gate does not work during high water (floods) periods Headwall will break up and depart, leaving pipeline unprotected May block, reduce, or divert effluent flow

(TASK STATEMENT) OPERATE, MAINTAIN, SAMPLE, ANALYZE, AND EVALUATE PERFORMANCE OF SEWAGE TREATMENT PLANT OUTFALLS

SCIENCE	MATH – NUMBER SYSTEMS
Simple machines used to gain mechanical advantage [tools] Effect of heating and cooling on expansion of materials [motor, blower, pumps] Fluids under pressure [gas, oxygen] Force ·ting on a body immersed or floating in a liquid [pumps] Transfe· of energy from one form to another [pumps] Inertia and momentum [pumps] Effects of friction on work processes and product quality [motor, blower, pumps, valves] Arrangement of molecules, atoms, and ions, and the effect on structure and strength of materials [motor, blower, pumps, valves] Resistance of materials to change in shape [motor, blower, pumps, and valves] Behavioral science (see appendix)	Positive rational numbers Use of numbers (without calculation) Counting Measurement: non-geometric Time, temperature, and speed (example: feet per minute, R.P.M., etc.) Read and interpret tables, charts, and graphs – representational graphs Basic logic Deductive or inductive Implications/converse/inverse/contrapositive Arguments/test for validity

COMMUNICATIONS

PERFORMANCE MODES	EXAMPLES	SKILLS/CONCEPTS
Speaking Reading Writing Viewing Touching Smelling Listening		Terminology/general vocabulary, logic, and usage Comprehension, informational reports, recommendation reports, progress reports Memo format, description, reports, terminology/general vocabulary, clarity of expression, and logic Visual analysis (seeing the parts in relation to the whole), logic (ordering of thoughts) Temperature Fire and septic odor Noise discrimination

APPENDIX
BEHAVIORAL SCIENCE

Professionalism

A. Maintain capacity to foster trust
B. Maintain capacity to foster confidentiality
C. Maintain capacity to foster cooperation
D. Maintain capacity to generate integrity
E. Maintain capacity to cope with conflict behavior
F. Maintain capacity to function efficiently when encountering fast changing, multiple, personal or situational varibles
G. Exhibit qualities of self-confidence, self-control, self-reliance, self-respect, and adaptability

Supervision

A. Distribute personnel with regard to leadership qualities and experiences for optimum team performance
B. Maintain customer's illusion of privacy by avoiding excessive noise or movement
C. Grant appropriate regard for customer's personal space (convenience and special interest)
D. Grant conscious attention to smoothly flowing team work
E. Maintain regard for differing views on maximum efficiency of the operations
F. Grant appropriate regard for customer's unique needs
G. Exhibit capacity to ascertain best service for the particular party type requested
H. Show and describe facilities with appropriate speed and clarity
I. Communicate pride in establishment

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Attributes of Maximum Functioning Capacity

Conscious awareness of the need for a balance (both physical and mental) between tension and relaxation. Relates to:

1. Comfort
2. Caution
3. Safety
4. Physical, emotional, and intellectual health

Conscious awareness of physical expressions basic to peak physical performance:

1. Body rhythm
2. Breathing coordinated with body movement
3. Body balance and posture
4. Movement from tension to relaxation and vice versa

Conscious awareness of qualities basic to optimal mental performance:

1. Attention
2. Observation
3. Concentration
4. Mental alertness
5. Mental quietude
6. Mental clarity
7. Organization

TOOL KITS

Standard Maintenance Mechanics Hand Tool Kit

Needle nose pliers
Side cutting pliers
Water pump pliers
Wrench sets: Box end, Open end, Socket and Allen
Assorted electrical screwdrivers (Conventional and Phillips)
Putty knife
6' folding rule
6", 8", and 12" crescent wrench
Pipe cutter and threader
Vise grips
24" pipe wrench
14" pipe wrench
8" pipe wrench
Hack saw
Pry bar
Assorted files
Feelers gauge
12' steel rule
2 lb. machinist hammer
6 lb. small sledge
Wire brush
Electrical tape
Teflon tape
Pocket knife

TOOL KITS

Standard Operators Tool Kit (SOTK)

- 6", 8", and 12" crescent wrench
- One set Allen wrenches
- Vise grip pliers
- Assorted electrical screwdrivers
- Machinist hammer
- 12' steel tape
- Pipe wrench

GLOSSARY OF TERMS USED IN WASTEWATER TREATMENT

Acid – (1) A substance that tends to lose a proton. (2) A substance that dissolves in water with the formation of hydrogen ions. (3) A substance containing hydrogen which may be replaced by metals to form salts.

Activated Carbon – Carbon particles usually obtained by carbonization of cellulosic material in the absence of air and possessing a high adsorptive capacity.

Activated Sludge – Sludge floc produced in raw or settled wastewater by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning floc previously formed.

Activated Sludge Loading – The pounds of biochemical oxygen demand (BOD) in the applied liquid per unit volume of aeration capacity or per pound of activated sludge per day.

Activated Sludge Process – A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) be sedimentation and wasted or returned to the process as needed.

Activation – (1) The generation, under aerobic conditions, of organisms capable of absorbing organic material from the water in the activated sludge process.

Aerated Pond – A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supplement the oxygen supply.

Aeration – (1) The bringing about of intimate contact between air and a liquid by one or more of the following methods: (a) spraying the liquid in the air, (b) bubbling air through the liquid, (c) agitating the liquid to promote surface absorption of air. (2) The supplying of air to confined spaces under nappes, downstream from gates in

conduits, etc., to relieve low pressures and to replenish air entrained and removed from such confined spaces by flowing water. (3) Relief of the effects of cavitation by admitting air to the section affected.

Aeration Period – (1) The theoretical time, usually expressed in hours, during which mixed liquor is subjected to aeration in an aeration tank while undergoing activated sludge treatment. It is equal to the volume of the tank divided by the volumetric rate of flow the the wastewater and return sludge. (2) The theoretical time during which water is subjected to aeration.

Aeration Tank – A tank in which sludge, wastewater, or other liquid is aerated.

Aerobic – Requiring, or not destroyed by, the presence of free elemental oxygen.

Aerobic Bacteria – Bacteria that require free elemental oxygen for their growth.

Aerobic Digestion – Digestion of suspended organic matter by means of aeration. See Digestion.

Agglomeration – The coalescence of dispersed suspended matter into larger flocs or particles which settle rapidly.

Agitator – Mechanical apparatus for mixing and/or aerating; a device for creating turbulence.

Air-Lift – A device for raising liquid by injecting air in and near the bottom of a riser pipe submerged in the liquid to be raised.

Air Relief Valve – An air valve placed at the summit of a pipeline to release the air automatically and prevent the pipeline from becoming air-bound with a resultant increase of pressure.

Algae – Primitive plants, one- or many-celled, usually aquatic, and capable of elaborating their foodstuffs by photosynthesis.

Algal Bloom — Large masses of microscopic and macroscopic plant life, such as green algae occurring in bodies of water. See Bloom.

Alum — A common name in the water and wastewater treatment field, for commercial-grade aluminum sulfate.

Amp Meter — An electrical measuring device which shows the flow of current through an electrical circuit.

Anaerobic — Requiring, or not destroyed by, the absence of air or free (elemental) oxygen.

Anaerobic Bacteria — Bacteria that grow only in the absence of free elemental oxygen.

Anaerobic Digestion — The degradation of organic matter brought about through the action of microorganisms in the absence of elemental oxygen.

Appurtences — Machinery, appliances, or auxiliary structures attached to a main structure to enable it to function, but not considered an integral part of it.

Assimilative capacity — The capacity of a natural body of water to receive: (a) wastewaters, with deleterious effects; (b) toxic materials, without damage to aquatic life or humans who consume the water; (c) BOD, within prescribed dissolved oxygen limits.

Available Chlorine — A measure of the total oxidizing power of chlorinated lime and hypochlorites.

Available oxygen — The quantity of dissolved oxygen available for oxidation of organic matter in a water body.

Axial-Flow Pump — A type of centrifugal pump which develops most of its head by the propelling or lifting action of the vanes on the liquids. Also called propeller pump.

Back Wash — The reversal of flow through a rapid sand filter to wash clogging material out of the filtering medium and restore conditions causing loss of head. Also called filter wash.

Bacteria — A group of universally distributed, rigid, essentially unicellular microscopic organisms lacking chlorophyll. Bacteria usually appear as speroid, rod-like, or curved entities, but occasionally appear as sheets, chains, or branched filaments. Bacteria are usually regarded as plants.

Baffles — Deflector vanes, guides, grids, gratings, or similar devices constructed or placed in flowing water, wastewater, or slurry systems to check or effect a more uniform distribution of velocities; absorb energy; divert guide, or agitate the liquids; and check eddies.

Ball Valve — A simple non-return valve consisting of a ball resting on a cylindrical seat within a fluid passageway.

Bar Rack — A screen composed of parallel bars, either vertical or inclined, placed in a waterway to catch debris. The screenings may be raked from it. Also called rack.

Biochemical Process — The process by which the life activities of bacteria and other microorganisms, in search for food, break down complex organic materials into simple, more stable substances. See Oxidation Process.

Biological Filter — A bed of sand, gravel, broken stone, or other medium through which wastewater flows or trickles that depends on biological action for its effectiveness.

Biological Oxidation — The process whereby living organisms in the presence of oxygen, convert the organic matter contained in wastewater into a more stable or a mineral form.

Biological Wastewater Treatment — Forms of wastewater treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Intermittent sand filters, contact beds, trickling filters, and activated sludge processes are examples.

Biota — Animal and plant life, or fauna and flora, of a stream or other water body.

BOD — (1) Abbreviation for biochemical oxygen demand. The quantity of oxygen used in the biochemical axidation of organic matter in a specified time, at a specified temperature, and under specified conditions. (2) A standard test used in assessing wastewater strength.

BOD Load – The BOD content, usually expressed in pounds per unit of time, of wastewater passing into a waste treatment system or to a body of water.

Breakpoint Chlorination – Addition of chlorine to water or wastewater until the chlorine demand has been satisfied and further additions result in a residual that is directly proportional to the amount added beyond the breakpoint.

Buffer – Any of certain combinations of chemicals used to stabilize the pH values or alkalinities of solutions.

Bulking Sludge – An activated sludge that settles poorly because of a floc of low density.

Butterfly Valve – A valve wherein the disk, as it opens or closes, rotates about a spindle supported by the frame of the valve. The valve is opened at a stem. At full opening, the disk is in a position parallel to the axis of the conduit.

Bypass – An arrangement of pipes, conduits, gates, and valves whereby the flow may be passed around a hydraulic structure or appurtenance.

Calibration – (1) The determination, checking, or rectifying of the graduation of any instrument giving quantitative measurements. (2) The process of taking measurements or of making observations to establish the relationship between two quantities.

Capolletti Weir – A flow measuring weir designed to handle both high and low flows accurately.

Cavitation – (1) The action resulting from forcing a flowing stream to change direction in which reduced internal pressure causes dissolved gases to expand, creating negative pressure. Cavitation frequently causes pitting of the hydraulic structure affected. (2) The formation of a cavity between the downstream surface of a moving body, for example, the blade of a propeller, and a liquid normally in contact with it.

Centigrade – A thermometer temperature scale in which 0 degrees marks the freezing point, and 100 degrees the boiling point of water at 760 mm of mercury barometric pressure. Also called Celsius scale. To convert temperature on this scale to Fahrenheit, multiply by 9/5 and add 32.

Centrifugal Pump — A pump consisting of an impeller fixed on a rotating shaft and enclosed in a casing, and having an inlet and a discharge connection. The rotating impeller creates pressure in the liquid by the velocity derived from centrifugal force.

Check Valve — A valve provided with a disk hinged on one edge so that it opens in the direction of normal flow and closes with reversal of flow. An approved check valve is of substantial construction and suitable materials, is positive in closing, and permits no leakage in a direction opposite to the normal flow.

Chemical Coagulation — The destabilization and initial aggregation of colloidal and finely divided suspended matter by the addition of a floc-forming chemical. Also see Flocculation.

Chemical Dose — The application of a specific quantity of chemical to a specific quantity of fluid for a specific purpose. Also see Dose.

Chemical Feeder — A device for dispensing a chemical at a predetermined rate for the treatment of water or wastewater. Change in rate of feed may be affected manually or automatically by flow-rate changes. Feeders are designed for solids, liquids, or gases.

Chemical Oxygen Demand (COD) — A measure of the oxygen-consuming capacity of inorganic and organic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test. It does not differentiate between stable and unstable organic matter and thus does not necessarity correlate with biochemical oxygen demand. Also known as OC and DOC, oxygen consumed and dichromate oxygen consumed, respectively.

Chemical Precipitation — (1) Precipitation induced by addition of chemicals. (2) The process of softening water by the addition of lime or lime and soda ash as the precipitants.

Chemical Sludge — Sludge obtained by treatment of wastewater with chemicals.

Chemical Treatment — Any process involving the addition of chemicals to obtain a desired result.

Chlorination – The application of chlorine to water or wastewater, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

Chlorine Contact Chamber – A detention basin provided primarily to secure the diffusion of chlorine through the liquid. Also called chlorination chamber.

Chlorine Demand – The difference between the amount of chlorine added to water or wastewater and the amount of residual chlorine remaining at the end of a specified contact period. The demand for any given water varies with the amount of chlorine applied, time of contact, and temperature. See Free Available Chlorine, Free Available Residual Chlorine.

Clarified Wastewater – Wastewater from which most of the settleable solids have been removed by sedimentation. Also called settled wastewater.

Coagulant – A compound responsible for coagulation: a floc-forming agent.

Coagulant Aid – Any chemical or substance used to assist or modify coagulation.

Coagulation – In water and wastewater treatment, the destabilization and initial aggregation of colloidal and finely divided suspended matter by the addition of a floc-forming chemical or by biological processes.

Coarse Rack – A rack with wide spaces between bars, usually of one inch or more.

Colloidal Matter – Finely divided solids which will not settle but may be removed by coagulation or biochemical action or membrane filtration. See Colloids.

Complete Treatment – In an imprecise and general sense, the processing of domestic and some industrial wastewaters by means of primary and secondary treatment. It may include other specialized types of treatment and disinfection. A high percentage removal of suspended, colloidal, and dissolved organic matter is implied.

Composite Wastewater Sample – A combination of individual samples of water or wastewater taken at selected intervals, generally hourly for some specified period, to minimize the effect of the variability of the individual sample. Individual samples may have equal volume or may be roughly proportioned to the flow at time of sampling.

Cone Valve — A valve in which the moving plug is conical; the valve is opened by unscrewing the plug from the seat and turning it through an angle of ninety degrees. Also called conical plug valve.

Contact Stabilization Process — A modification of the activated sludge process in which raw wastewater is aerated with a high concentration of activated sludge for a short period, usually less than sixty minutes, to obtain BOD removal by absorption. The solids are subsequently removed by sedimentation and transferred to a stabilization tank where aeration is continued further to oxidize and condition them before their reintroduction to the raw wastewater flow.

Cross Connection — (1) A physical connection through which a supply of potable water could be contaminated or polluted. (2) A connection between a supervised potable water supply and an unsupervised supply of unknown potability.

Cubic Foot Per Second (cfs) — A unit of measure of the rate of liquid flow past a given point equal to one cubic foot in one second. Previously also called second—foot.

Decomposition of Wastewater — (1) The breakdown of organic matter in wastewater by bacterial action either aerobic or anaerobic. (2) Transformation of organic or inorganic materials contained in wastewater through the action of chemical or biological processes.

Degradation — (1) The breakdown of substances by biological action.

Degree of Treatment — A measure of the removal effected by treatment processes with reference to solids, organic matter, BOD, bacteria, or any other specified matter.

Deposition — The act or process of settling solid material from fluid suspension.

Detention Time — The theoretical time required to displace the contents of a tank or unit at a given rate of discharge (volume divided by rate of discharge).

Diffused— Air aeration — Aeration produced in a liquid by air passed through a diffuser.

Diffuser — A mechanical device designed to convert an air stream into a continuous stream of air bubbles in a decreasing size range.

Digested Sludge — Sludge digested under either aerobic or anaerobic conditions until the volatile content has been reduced to the point at which the solids are relatively nonputrescible and inoffensive.

Disinfection — The art of killing the larger portion of microorganisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

Dispersion — (1) Scattering and mixing. (2) The mixing of polluted fluids with a large volume of water in a stream or other body of water.

Dissolved Oxygen — The oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation. Abbreviated DO .

Dissolved-Oxygen Sag Curve — A curve that represents the profile of dissolved oxygen content along the course of a stream resulting from deoxygenation associated with biochemical oxidation of organic matter and reoxygenation through the absorption of atmospheric oxygen and biological photosynthesis. Also called oxygen-sag curve.

Dissolved Solids — Theoretically, the anhydrous residues of the dissolved constituents in water. Actually, the term is defined by the method used in determination. In water and wastewater treatment, the Standard Methods tests are used.

Ditch Oxidation — A modification of the activated sludge process or the aerated pond, in which the mixture under treatment is circulated in an endless ditch and aeration and circulation are produced by a mechanical device such as a Kessener brush.

Domestic Wastewater — Wastewater derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain ground water, surface water, or storm water.

Dose — (1) The quantity of substance applied to a unit quantity of liquid for treatment purposes. It can be expressed in terms of either volume or weight, e.g., pounds per million gallons, parts per million, grains per gallon, milligrams per liter, or grams per cubic meter.

Dosing tank — Any tank used in applying a dose. Specifically used for intermittent application of wastewater to subsequent processes.

Dry Feeder — A feeder for dispensing a chemical or other fine material in the solid state to water or wastewater at a rate controlled manually or automatically by the rate of flow. The constant rate may be either volumetric or gravimetric.

Duplex Pump — A reciprocating pump consisting of two consisting of two cylinders placed side by side and connected to the same suction and discharge pipe; the pistons move so that one exerts suction while the other exerts pressure, with the result that the discharge from the pump is continuous.

Dynamic Head — (1) When there is flow: (2) the head against which a pump works. (3) That head of fluid which would produce statically the pressure of a moving fluid.

Efficiency — The relative results obtained in any operation in relation to the energy or effort required to achieve such results. It is the ratio of the total output to the total input, expressed as a percentage.

Effluent — (1) A liquid which flows out of a containing space. (2) Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial treatment plant, or part thereof. (3) An outflowing branch of a main stream or lake.

Effluent Weir — A weir at the outflow end of a sedimentation basin or other hydraulic structure.

End Point — The stage in a titration at which equivalence is attained and revealed by a change that can be observed or measured, such as color development, formation of a precipitate, or reaching a specified pH.

Escherichia Coli (E. Coli.) — One of the species of bacteria in the coliform group. Its presence is considered indicative of fresh fecal contamination.

Excess Sludge — The sludge produced in an activated sludge treatment plant that it not needed to maintain the process and is withdrawn from circulation.

Exfiltration — The quantity of wastewater which leaks to the surrounding ground through unintentional openings in a sewer. Also, the process whereby this leaking occurs.

Explosimeter — An instrument designed to give warning of an explosive mixture of oxygen and combustible gas.

Extended Aeration — A modification of the activated sludge process which provides for aerobic sludge digestion within tne aeration system. The concept envisages the stabilization of organic matter under aerobic conditions and disposal of the end products into the air as gases and with the plant effluent as finely divided suspended matter and soluble matter.

Fahrenheit — A temperature scale in which 32 degrees marks the freezing point, and 212 degrees the boiling point of water at a 760 mm barometric pressure. To convert to centigrade (Celsius), subtract 32, and multiply by 5/9.

Final Effluent — The effluent from the final treatment unit of a wastewater treatment plant.

Fine Rack — A relative term, but generally, a rack which has clear spaces of one inch or less between its bars.

Five-Day BOD — That part of oxygen demand associated with biochemical oxidation of carbonaceous, as distinct from nitrogeneous, material. It is determined by allowing biochemical oxidation to proceed, under conditions specified in Standard Methods, for five days. See Firststage Biochemical Oxygen Demand.

Fixed Solids — The residue remaining after ignition of suspended or dissolved matter according to Standard Methods.

Flame Arrester — A device incorporating a fine-mesh wire screen or tube bundle inserted in a vent or pipe and designed to resist the flashback of flame.

Flanged Pipe — A pipe provided with flanges so that the ends can be joined together by means of bolts.

Flash Mixer — A device for quickly dispersing chemicals uniformly throughout a liquid.

Flocculating Tank — A tank used for the formation of floc by the gentle agitation of liquid suspensions, with or without the aid of chemicals

Flocculation — In water and wastewater treatment, the agglomeration of colloidal and finely divided suspended matter after coagulation by gentle stirring by either mechanical or hydraulic means. In biological wastewater treatment where coagulation is not used, agglomeration may be accomplished biologically.

Flocculation Agent — A coagulating substance which, when added to water forms a flocculent precipitate which will entrain suspended matter and expedite sedimentation; examples are alum, ferrous sulfate, and lime.

Flocculator — (1) A mechanical device to enhance the formation of floc in a liquid. (2) An apparatus for the formation of floc in water and wastewater.

Flotation — The raising of suspended matter to the surface of the liquid in a tank as scum --by aeration, the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition-- and the subsequent removal of the scum by skimming.

Flow Regulator — A structure installed in a canal, conduit, or channel to control the flow of water wastewater at intake or to control the water level in a canal, channel, or treatment unit. Also see rate-of-flow controller, regulator.

Flume — An open channel for transporting liquids.

Foot Valve — A valve placed in the bottom of the suction pipe of a pump, which opens to allow water to enter the suction pipe, but closes to prevent water from passing out of it at the bottom end.

Force Main — A pressure pipe joining the pump discharge at a water or wastewater pumping station with a point of gravity flow.

Free Available Chlorine — The amount of chlorine available as dissolved gas, hypochlorous acid, or hypochlorite ion that is not combined with an amine or other organic compound.

Free Available Residual Chlorine – That portion of the total residual chlorine remaining in water or wastewater at the end of a specified contact period which will react chemically and biologically as hypochlorous acid or hypochlorite ion.

Free Residual Chlorination – The application of chlorine or chlorine compounds to water or wastewater to produce a free available chlorine residual directly or through the destruction of ammonia or certain organic nitrogenous compounds.

Fresh Sludge – Sludge in which decomposition is little advanced.

Fresh Wastewater – Wastewater of recent origin containing dissolved oxygen.

Fungi – Small non-chlorophyll-bearing plants which lack roots, stems, or leaves, which occur (among other places), in water, wastewater, or wastewater effluents and grow best in the absence of light. Their decomposition after death may cause disagreeable tastes and odors in water; in some wastewater treatment processes, they are helpful and in others they are detrimental.

Gas Dome – In sludge-digestion tanks, usually a steel cover floating entirely or in part on the liquid sludge.

Gas Vent – (1) A passage to permit the escape of gases. (2) An opening which allows gas liberated in an Imhoff tank sludge chamber to reach the atmosphere without passing up through the wastewater in the settling chamber.

Gate Valve – A valve in which the closing element consists of a disk which slides over the opening or cross-sectional area through which water passes, and fits tightly against it.

Globe Valve – A valve having a round, ball like shell and horizontal disk.

Grab Sample – A single sample of wastewater taken at neither set time nor flow.

Graduated Cylinder – A cylinder designed to measure volume in discreet increments.

Gravimetric — Of or pertaining to measurement by weight.

Grease — In wastewater, a group of substances including fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other nonfatty materials. The type of solvent and method used for extraction should be stated for quantitation.

Grease Skimmer — A device for removing floating grease or scum from the surface of wastewater in a tank.

Grit — The heavy suspended mineral matter present in water or wastewater, such as sand, gravel, cinders.

Grit Chamber — A detention chamber or an enlargement of a sewer designed to reduce the velocity of flow of the liquid to permit the separation of mineral from organic solids by differential desimentation.

Head — The height of the free surface of fluid above any point in a hydraulic system; a measure of the pressure or force exerted by the fluid.

Heat Exchanger — A device providing for the transfer of heat from a fluid flowing in tubes to another fluid outside the tubes, or vice versa.

Heavy Metals — Metals that can be precipitated by hydrogen sulfide in acid solution, for example, lead, silver, gold, mercury, bismuth, copper.

High—Rate Digestion — Accelerated anaerobic digestion resulting primarily from thorough mixing of digester contents. May be enhanced by thermophilic digestion.

High-Rate Filter — A trickling filter operated at a high average daily dosing rate, usually between 10 and 40 mgd/acre including any recirculation of effluent.

Horizontal Pump — (1) A reciprocating pump in which the piston or plunger moves in a horizontal direction. (2) A centrifugal pump in which the pump shaft is in a horizontal position.

Humus Sludge — Sludge deposited in final or secondary settling tanks following trickling filters or contact beds.

Hydraulic Jump — An abrupt rise in water surface which may occur in an open channel when water flowing at a high velocity is retarded.

Hydrogen—Ion Concentration — The weight of hydrogen ion in moles per liter of solution. Commonly expressed as the pH value, which is the logarithm of the reciprocal of the hydrogen-ion concentration.

Hydrometer — An instrument designed to measure the specific gravity of liquids or slurries either in specific gravity units or degrees baume'.

Hydrostatic Sludge Removal — The discharge of sludge from hopper-bottomed sedimentation tanks by use of the hydrostatic pressure of the wastewater above the sludge oulet.

Imhoff Cone — A cone-shaped graduated glass vessel used to measure the approximate volume of settleable solids in various liquids of wastewater origin during various settling times.

Imhoff Tank — A deep, two-storied wastewater tank originally patented by Karl Imhoff. It consists of an upper continuous-flow sedimentation chamber and a lower sludge-digestion chamber. The floor of the upper chamber slopes steeply to trapped slots through which solids may slide into the lower chamber. The lower chamber receives no fresh wastewater directly, but is provided with gas vents and with means for drawing digested sludge from near the bottom.

Immediate Biochemical Oxygen Demand — (1) The initial quantity of oxygen used by polluted liquid immediately upon being introduced into water containing dissolved oxygen. It may be exercised by end products of prior biochemical action or by chemical substances avid for oxygen. (2) In the standard laboratory procedure, the apparent BOD for fifteen minutes at 20 degrees Centigrade.

Impeller — A rotating set of vanes designed to impel rotation of a mass of fluid.

Industrial Wastes — The liquid wastes from industrial processes, as distinct from domestic or sanitary wastes.

Infiltration — The quantity of groundwater that leaks into a pipe through joints, porous walls, or breaks.

Infiltration Rate — (1) The rate at which water enters the soil or other porous material under a given condition. (2) The rate at which infiltration takes place, expressed in depth of water per unit time, usually in inches per hour. (3) The rate, usually expressed in cubic feet per second or million gallons per day per mile of waterway at which groundwater enters an infiltration ditch or gallery, drain, sewer, or other underground conduit.

Influent — Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant, or any unit thereof.

Inorganic Matter — Chemical substances of mineral origin, or more correctly, not of basically carbon structure.

Intermediate Treatment — The removal of a high percentage of suspended solids and a substantial percentage of colloidal matter, but little dissolved matter.

Lagoon — A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Lagooning — The placement of solid or liquid material in a basin, reservoir, or artificial impoundment for purposes of storage, treatment, or disposal.

Lime — Any of a family of chemicals consisting essentially of calcium hydroxide made from limestone (calcite) which is composed almost wholly of calcium carbonate or a mixture of calcium and magnesium carbonate.

Liquid Chlorine — Elemental chlorine placed in a liquid state by a combination of compression and refrigeration of dry, purified chlorine gas. Liquid chlorine is shipped under pressure in steel containers.

Loss of Head — The difference between the total heads at two points in a hydraulic system.

Low-Rate Filter — A trickling filter designed to receive a small load of BOD per unit volume of filtering material and to have a low dosage rate per unit of surface area, usually one to four million gallons per day per acre, and generally without recirculation. Organic loading (BOD) rate is usually in the range of 5 to 25lb/1,000 cu ft. Also called standard-rate filter.

Maintenance — The upkeep necessary for efficient operation of physical properties. It involves labor and materials, but is not to be confused with replacement or retirement.

Manometer — An instrument for measuring pressure. It usually consists of a U-shaped tube containing a liquid, the surface of which in one end of the tube moves proportionally with changes in pressure on the liquid in the other end. Also, a tube type of differential pressure gage.

Mechanical Aeration — (1) The mixing, by mechanical means, of wastewater and activated sludge in the aeration tank of the activated sludge process to bring fresh surfaces of liquid into contact with the atmosphere. (2) The introduction of atmospheric oxygen into a liquid by the mechanical action of paddle, paddle wheel, spray or turbine mechanisms.

Mechanical Aerator — A mechanical device for the introduction of atmospheric oxygen into a liquid. See Mechanical Aeration.

Mechanical Rake — A machine-operated mechanism used for cleaning debris from racks located at the intakes of conduits supplying water to hydroelectric power plants, to water supply systems, or for other uses, and conveying wastewater to pumps or treatment processes.

Mesophilic Range — Operationally, that temperature range most conducive to the maintenance of optimum digestion by medophilic bacteria, generally accepted as between 27 degrees and 32 degrees Centigrade (80 degrees and 90 degrees Fahrenheit). See Mesophilic Digestion.

Methane Fermentation — Fermentation resulting in conversion of organic matter into methane gas.

Microbial Activity — Chemical changes resulting from the metabolism of living organisms. Biochemical action.

Milligrams Per Liter — A unit of the concentration of water or wastewater constituent. It is 0.001 g of the constituent in 1,000 ml of water. It has replaced the unit formerly used commonly, parts per million, to which it is approximately equivalent, in reporting the results of water and wastewater analysis.

Mixed–Flow Pump — A centrifugal pump in which the head is developed partly by centrifugal force and partly by the lift of the vanes on the liquid. This type of pump has a single inlet impeller; the flow enters axially and leaves axially and radially.

Mixed Liquor — A mixture of activated sludge and organic matter undergoing activated sludge treatment in the aeration tank.

Mixing Tank — A tank designed to provide a thorough mixing of chemicals introduced into liquids or of two or more liquids of different characteristics.

Modified Aeration — A modification of the activated sludge process in which a shortened period of aeration is used with a reduced quantity of suspended solids in the mixed liquor.

Mud Valve — A plug valve for draining out sediment, inserted in the bottom of settling tanks.

Multistage Pump — A centrifugal pump with two or more sets of vanes or impellers connected in series in the same casing. Such a pump may be designated as two-stage, three-stage, or more, according to the number of sets of vanes used.

Needle Valve — A valve with a circular outlet through which the flow is controlled by means of a tapered needle which extends through the outlet, reducing the area of the outlet as it advances and enlarging the area as it retreats.

Nitrification — The conversion of nitrogenous matter into nitrates by bacteria.

Nitrogen Cycle — A graphical presentation of the conservation of matter in nature, from living animal matter through dead organic matter, various stages of decomposition, plant life, and the return of living animal matter, showing changes which occur in course of the cycle. It is used to illustrate biological action and also aerobic and anaerobic acceleration of the transformation of this element by wastewater and sludge treatment.

Nonclogging Impeller — An impeller of the open, closed, or semiclosed type designed with large passages for passing large solids.

Nonsettleable Solids — Wastewater matter that will stay in suspension for an extended period of time. Such period may be arbitrarily taken for testing purposes as one hour.

Notched Weir — A weir having a substantial width of crest broken at intervals by a notch of known hydraulic characteristics, usually a V-notch. Also see Broad-Crested Weir.

Odor Control — In wastewater treatment, the prevention or reduction of objectionable odors by chlorination, aeration, or other processes or by making with chemical aerosols.

Open Channel — Any natural or aritficial waterway or conduit in which water flows with a free surface.

Organic Matter — Chemical substances of animal or vegetable origin, or more correctly, of basically carbon structure, comprising compounds consisting of hydrocarbons and their derivatives.

Organic Overload — Influent BOD loading in excess of design capacity on any unit.

Orthotolidine Test — A technique for determining residual chlorine in water by ...ng orthotolidine reagent and choloimetric standards. It is used for routine m...ement; however, its accuracy is affected by interfering substances and color.

Outfall Sewer — A sewer that receives wastewater from a collecting system or from a treatment plant and carries it to a point of final discharge.

Overflow Rate — One of the criteria for the design of settling tanks in treatment plants; expressed in gallons per day per square foot of surface area in the settling tank.

Overflow Weir — Any device or structure over which any excess water or wastewater beyond the capacity of the conduit or container is allowed to flow or waste. See Diverting Weir.

Overhead — Those elements of indirect cost necessary to produce an article or perform a service of such nature that the amount applied to each unit of product or service cannot be determined readily or accurately and is thus usually allocated on some arbitrary basis. Normally, overhead relates to those objects of expenditure which do not become an integral part of the finished product or service, such as rent, light, supplies, management, and supervision.

Oxidation — The addition of oxygen to a compound. More generally, any reaction which involves the loss of electrons from an atom.

Oxidation Pond — A basin used for retention of wastewater before final disposal, in which biological oxidation of organic material is effected by natural or artificially accelerated transfer of oxygen to the water from air.

Oxidation Rate — The rate at which the organic matter in wastewater is stabilized.

Oxygenation Capacity — In treatment processes, a measure of the ability of an aerator to supply oxygen to a liquid.

Oxygen Consumed — A measure of the oxygen-consuming capability of inorganic and organic matter present in water or wastewater. See Chemical Oxygen Demand.

Oxygen Deficiency — (1) The additional quantity of oxygen required to satisfy the oxygen requirement in a given liquid. Usually expressed in milligrams per liter. (2) Lack of oxygen.

Oxygen Demand — (1) The quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions. See BOD.

Oxygen Depletion — Loss of dissolved oxygen from water or wastewater resulting from biochemical or chemical action.

Oxygen Reduction Potential Meter — An electrical measuring device designed to show whether the electrical charge of a solution is positive or negative.

Oxygen-Sag Curve — A curve that represents the profile of dissolved oxygen content along the course of a stream, resulting from deoxygenation associated with biochemical oxidation of organic matter and reoxygenation through the absorption of atmospheric oxygen and through biological photosynthesis Also called dissolved-oxygen-sag-curve.

Oxygen Saturation — The maximum quantity of dissolved oxygen that liquid of given chemical characteristics, in equilibrium with the atmosphere, can contain at a given temperature and pressure.

Oxygen Utilization — (1) The oxygen consumed or utilized to support aerobic biological treatment processes. (2) The oxygen used to support combustion in the degradation of sludge by incineration or wet air oxidation.

Ozone — Oxygen in molecular form with three atoms of oxygen forming each molecule (O_3).

Parshall Flume — A calibrated device developed by Parshall for measuring the flow of liquid in an open conduit. It consists essentially of a contracting length, a throat, and an expanding length. At the throat is a sill over which the flow passes at Belanger's critical depth. The upper and lower heads are each measured at a definite distance from the sill. The lower head need not be measured unless the sill is submerged more than about sixty-seven percent.

Pathogenic Bacteria — Bacteria which may cause disease in the host organisms by their parasitic growth.

Pathogens — Pathogenic or disease-producing organisms.

Peak Load — The maximum rate of flow of wastewater to a pumping station or treatment plant. Also called peak demand.

Peripheral Flow — Flow of water or other liquid parallel to the circumference or periphery of a circular tank or other circular structure. Also called circumferential flow.

Peripheral Weir — The outlet weir extending around the inside of the circumference of a circular settling tank, over which the effluent discharges.

Pet Cock — A small cock used to drain a cylinder, fitting, valve, or similar device.

pH — The reciprocal of the logarithm of the hydrogen-ion concentration. The concentration is the weight of hydrogen ions, in grams, per liter of solution. Neutral water, for example, has a pH value of seven and a hydrogen-ion concentration of ten to the negative seven exponent.

Phenolic Compounds — Hydroxy derivatives of benzene. The simplest phenolic compound is hydroxy benzene, C_6H_5OH.

Phenol Wastes — Industrial wastes containing phenols, derived chiefly from coking processes and oil refineries.

Photosynthesis — The synthesis of complex organic materials, especially carbohydrates, from carbon dioxide, water, and inorganic salts, with sunlight as the source of energy, and with the aid of a catalyst such as chlorophyll.

Physical Analysis — The examination of water and wastewater to determine physical characteristics such as temperature, turbidity, color, odors, taste.

Pipe Gallery — (1) Any conduit for pipe, usually of a size to allow a man to walk through. (2) A gallery provided in a treatment plant for the installation of the conduits and valves and for a passageway to provide access to them.

Pipeline — Pipes jointed to provide a conduit through which fluids flow.

Pipette — A device for measuring and/or transfering of accurate amounts of liquids.

Piston Pump — A reciprocating pump wherein the cylinder is tightly fitted with a reciprocating piston.

Plain Sedimentation — The sedimentation of suspended matter in a liquid, unaided by chemicals or other special means and without provision for the decomposition of deposited solids in contact with the wastewater.

Plate Count — Number of colonies of bacteria grown on selected solid media at a given temperature and incubation period, usually expressed in number of bacteria per milliliter of sample.

Plug Valve — A valve in which the movable control element is a cylindrical or conical plug, in contrast to a flat disk.

Plunger Pump — A reciprocating pump having a plunger that does not come in contact with the cylinder walls, but enters and withdraws from it through packing glands. Such packing may be inside or outside the center, according to the design of the pump.

Pneumatic Ejector — A device for raising wastewater, sludge, or other liquid by alternately admitting it through an inward-swinging check valve into the bottom of an airtight pot and then discharging it through an outward-swinging check valve by admitting compressed air to the pot above the liquid.

Pollution — A condition created by the presence of harmful or objectionable material in water.

Pollutional Load — (1) The quantity of material in a waste stream that requires treatment or exerts an adverse effect on the receiving system. (2) The quantity of material carried in a body of water that exerts a detrimental effect on some subsequent use of that water.

Positive Head — The energy possessed per unit weight of a fluid, due to its elevation above some datum.

Post-Chlorination — The application of chlorine to water or wastewater subsequent to any treatment, including prechlorination.

Preaeration — A preparatory treatment of wastewater consisting of aeration to remove gases, add oxygen, promote flotation of grease, and aid coagulation.

Pre-Chlorination — The application of chlorine to water or wastewater prior to any treatment.

Precipitate — The separation from solution as a precipitate. The substance precipitated.

Precipitation — The total measurable supply of water received directly from clouds, as rain, snow, hail, or sleet; usually expressed as depth in a day, month, or year, and designated as daily, monthly, or annual precipitation.

Preliminary Treatment — (1) The conditioning of a waste at its source before discharge, to remove or to neutralize substances injurious to sewers and treatment processes, or to effect a partial reduction in load on the treatment process. (2) In the treatment process unit operation, such as screening and comminution, that prepare the liquor for subsequent major operations.

Pressure-Reducing Valve — A valve with a horizontal disk for reducing pressures automatically, according to the setting of the pressure-regulating valves.

Pressure-Regulating Valve — A valve placed at either end of a pressure-regulating apparatus inserted in a water main to regulate the pressure in a water line, either upstream or downstream from the valve.

Pressure Regulator — A device for controlling pressure in a pipeline or pressurized tank, such as a pressure-regulating valve or a pump drive-speed controller.

Pressure-Relief Valve — A valve that opens automatically to ample area when the pressure reaches an assigned limit, to relieve the stress on a pipeline.

Primary Settling Tank — The first settling tank for the removal of settleable solids through which wastewater is passed in a treatment works.

Primary Sludge — Sludge obtained from a primary settling tank.

Primary Treatment — (1) The first major (sometimes the only) treatment in a wastewater treatment workd, usually sedimentation. (2) The removal of a substantial amount of suspended matter but little or no colloidal and dissolved matter.

Priming — (1) The first filling with water of a canal, reservoir, or other structure built to contain water. (2) The action of starting the flow in a pump or siphon.

Protozoa — Small one-celled animals including amoebae, ciliates, and flagellants.

Psychoda — A small gray fly prevalent arount trickling filters. Their larvae live in the zoogloeal film on the filter stones and may serve some useful purpose, but they are primarily a nuisance.

Pump — A mechanical device for causing flow, for raising or lifting water or other fluid, or for applying pressure to fluids.

Pump Efficiency — The ratio of energy converted into useful work to the energy applied to the pump shaft, or the energy difference in the water at the discharge and suction nozzles divided by the power input at the pump shaft.

Pumping Head — The sum of the static head and friction head on a pump discharging a given quantity of water.

Pumping Station — A station housing relatively large pumps and their appurtenances. Pump house is the usual term for shelters for small water pumps.

Pump Pit — A dry well or chamber below ground level in which a pump is located.

Pump Primer — A vacuum pump attached to the suction end of a pump for priming the pump automatically.

Pump Stage — The number of impellers in a centrifugal pump; for example, a single-stage pump has one impeller; a two-stage pump has two impellers.

Pump Stroke — The lineal distance traveled by the piston or plunger or a reciprocating pump through one-half of its cycle of movement.

Quicklime — A calcined material the major part of which is calcium oxide or calcium oxide in natural association with a lesser amount of magnesium oxide. It is capable of slaking with water.

Rack — A device fixed in place and used to return or remove suspended or floating solids from wastewater and composed of parallel bars evenly spaced.

Rakings — The screenings or trash removed from bar screens cleaned manually or by mechanical rakes.

Rate-of-Flow Controller — An automatic device that controls the rate of flow of a fluid.

Rate-of-Flow Recorder — A recorder for registering the rate of flow of water, generally, used with a rapid sand filter.

Raw Sludge — Settled sludge promptly removed from sedimentation tanks before decomposition has much advance. Frequently referred to as undigested sludge.

Raw Wastewater — Wastewater before it receives any treatment.

Reaeration — The absorption of oxygen into water under conditions of oxygen deficit.

Receiving Body of Water — A natural watercourse, lake, or ocean into which treated or untreated wastewater is discharged.

Reciprocating Pump — A type of displacement pump consisting essentially of a closed cylinder containing a piston or plunger, as the displacing mechanism, drawing liquid into the cylinder through an inlet valve and forcing it out through an outlet valve. When the piston acts on the liquid in one end of the cylinder, the pump is termed single-action, and when it acts in both ends, it is termed double-action.

Recirculation — (1) In the wastewater field, the refiltration of all or a portion of the effluent in a trickling filter to maintain a uniform high rate through the filter. Return of a portion of the effluent to maintain minimum flow is sometimes called recycling. (2) The return of effluent to the incoming flow.

Recycling — An operation in which a substance is passed through the same series of processes, pipes, or vessels more than once.

Reducer — A pipe or pipe fitting having a smaller-size opening at one end than at the other.

Reducing Tee — Any tee having two different sizes of openings. It may reduce on the run or branch.

Relief Valve — A valve that releases air from a pipeline automatically without loss of water, or introduces air into a line automatically if internal pressure becomes less than that of the atmosphere.

Repairs — An element of maintenance, as distinguished from replacement or retirement.

Representative Sample — A small quantity of a substance that is representative of the entire substance.

Residual Chlorine — Chlorine remaining in water or wastewater at the end of a specified contact period as combined or free chlorine. See Free Available Residual Chlorine.

Residual Oxygen — The dissolved oxygen content of a stream after deoxygenation has begun.

Returned Sludge — Settled activated sludge returned to mix with incoming raw or primary settled wastewater.

Riprap — Broken stone or boulders placed compactly or irregularly on dams, levees, dikes, or similar embankments for protection of earth surfaces against the action of waves or currents.

Rotameter — A fluid-flow-measuring device utilizing a float, suspended in an upflowing fluid stream through a progressively increasing diameter tube.

Rotary Distributor — A movable distributor made up of horizontal arms that extend to the edge of the circular trickling filter bed, revolve about a central post, and distribute liquid over the bed through orifices in the arms. The jet action of the discharging liquid normally supplies the motive power.

Roughing Filter — A wastewater filter of relatively coarse material operated at a high rate to afford preliminary treatment.

Runoff — That part of the precipitation which runs off the surface of a drainage area and reaches a stream or other body of water or a drain or sewer.

Sampler — A device used with or without flow measurement to obtain an aliquot portion of water or waste for analytical purposes. May be designed for taking single sample (grab), composite sample, continuous sample, periodic sample.

Sanitary Wastewater — (1) Domestic wastewater with storm and surface water excluded.
(2) Wastewater discharging from the sanitary conveniences of dwelling (including apartment houses and hotels), office buildings, industrial plants, or institutions.
(3) The water supply of a community after it has been used and discharged into a sewer.

Screen — A device with openings, generally of uniform size, used to retain or remove suspended or floating solids in flowing water or wastewater and to prevent them from entering an intake or passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plat, and the openings may be of any shape, although they are usually circular or rectangular.

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Screen Chamber – A chamber in which screens are installed.

Screening – The removal of relatively coarse floating and suspended solids by straining through racks or screens.

Screenings – Material removed from liquids by screens.

Screenings Grinder (Comminutor) – A device for grinding, shredding, or macerating material removed from wastewater by screens.

Screenings Shredder – A device that disintegrates screenings.

Scum – (1) The layer of film of extraneous or foreign matter that rises to the surface of a liquid and is formed there. (2) A residue deposited on a container or channel at the water surface. (3) A mass of solid matter that floats on the surface.

Scum Baffle – A vertical baffle dipping below the surface of wastewater in a tank to prevent the passage of floating matter. Also called scum board.

Scum Collector – A mechanical device for skimming and removing scum from the surface of a settling tank.

Scum Trough – A trough placed in a primary settling tank to intercept scum and convey it out of the tank.

Secondary Settling Tank – A tank through which effluent from some prior treatment process flows for the purpose of removing settleable solids.

Secondary Wastewater Treatment – The treatment of wastewater by biological methods after primary treatment by sedimentation.

Second-Stage Biochemical Oxygen Demand – That part of the oxygen demand associated with the biochemical oxidation of nitrogenous material. As the term implies, the oxidation of the nitrogenous materials usually does not start until a portion of the carbonaceous material has been oxidized during the first stage.

Sedimentation — The process of subsidence and deposition of suspended matter carried by water, wastewater, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called settling.

Sedimentation Tank — A basin or tank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation basin, settling basin, settling tank.

Separate Sludge Digestion — The digestion of sludge in tanks separate from that in which it had been allowed to settle.

Septicity — A condition produced by growth of anaerobic organisms.

Sptic Sludge — Sludge from a septic tank or partially digested sludge from an Imhoff tank or sludge-digestion tank.

Septic Wastewater — Wastewater undergoing putrefaction under anaerobic conditions.

Settleability Test — A determination of the settleability of solids in a suspension by measuring the volume of solids settled out of a measured volume of sample in a specified interval of time, usually reported in milliliters per liter. Sometimes identified as the Imhoff cone test.

Settleable Solids — (1) That matter in wastewater which will not stay in suspension during a preselected settling period, such as one hour, but either settles to the bottom or floats to the top. (2) In the Imhoff cone test, the volume of matter that settles to the bottom of the cone in one hour.

Settled Wastewater — Wastewater from which most of the settleable solids have been removed by sedimentation. Also called clarified wastewater.

Settling Tank — A basin or bank in which water or wastewater containing settleable solids is retained to remove by gravity a part of the suspended matter. Also called sedimentation basin, sedimentation tank, settling basin.

Settling Velocity — The velocity at which subsidence and deposition of the settleable suspended solids in water and wastewater will occur.

Sewage Charge — A service charge made for providing wastewater colleciton and/or treatment service. A specific charge in contrast to an ad volorem tax.

Sewage Gas — (1) Gas resulting from the decomposition of organic matter in wastewater. (2) Gas produced during the digestion of sludge.

Sewage Rate — A charge, or a schedule of charges, for the collection, or the collection and treatment, of wastewater to users connected to the system, based on water consumption, wastewater flow, wastewater strength, number and types of plumbing fixtures, or some combination.

Sewer — A pipe or conduit that carries wastewater or drainage water.

Sewerage — System of piping, with appurtenances, for collecting and conveying wastewater from source to discharge. Term declining in use.

Sewer Appurtenances — Structures, devices, and appliances, other than pipe or conduit, that are integral parts of a sewer system.

Shear Gate — A pivoted slide, without guides, held in place by the pressure of the water and seating lugs. This type of gate is not watertight for reversed pressure.

Short-Circuiting — A hydraulic condition occurring in parts of a tank where the time of travel is less than the flowing-through time.

Side Water Depth — The depth of water measured along a vertical exterior wall.

Siphon — A closed conduit, a portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric and requiring a vacuum within the conduit to start flow. A siphon utilizes atmospheric pressure to effect or increase the flow of water through the conduit.

Skimming — The process of removing floating grease or scum from the surface of wastewater in a tank.

Skimmings — Grease, solids, liquids, and scum skimmed from wastewater settling tanks.

Slake — To become mixed with water so that a true chemical combination takes place, as in the slaking of lime.

Slimes — Substances of viscous organic nature, usually formed from microbiological growth.

Slot — (1) A narrow opening. (2) In an Imhoff tank, the opening provided for deflection of gas (see Gas Vent) or for the passage of deposited solids into the digestion chamber.

Sloughing — The disattachment of slime and solids accumulated on the media of trickling filters and contact areas. Sloughed material usually appears in the effluent.

Sludge — (1) The accumulated solids separated from liquids, such as water or wastewater, during processing, or deposits on bottoms of streams, or other bodies of water. (2) The precipitate resulting from chemical treatment, coagulation, or sedimentation of water or wastewater.

Sludge Age — In the activated sludge process, a measure of the length of time a particle of suspended solids has been undergoing aeration, expressed in days. It is usually computed by dividing the weight of the suspended solids in the aeration tank by the daily addition of new suspended solids having their origin in the raw waste.

Sludge Bank — Accumulated deposits of solids of wastewater or organic origin on the bottom, banks, edges, or shores of waterways or open water.

Sludge Bed — An area comprising natural or artificial layers of porous material on which digested wastewater sludge is dried by drainage and evaporation. A sludge bed may be open to the atmosphere or covered, usually with a greenhouse-type superstructure. Also called sludge drying bed.

Sludge Blanket — Accumulation of sludge hydrodynamically suspended within an enclosed body of water or wastewater.

Sludge Bulking — A phenomenon that occurs in activated sludge plants whereby the sludge occupies excessive volumes and will not concentrate readily.

Sludge Cake — The sludge that has been dewatered by a treatment process to a moisture content of sixty to eighty five percent, depending on type of sludge and manner of treatment.

Sludge Circulation — The overturning of sludge in sludge-digestion tanks by mechanical or hydraulic means or by use of gas recirculation to disperse scum layers and to promote digestion.

Sludge Collector — A mechanical device for scraping the sludge on the bottom of a settling tank to a sump from which it can be drawn.

Sludge Concentration — Any process of reducing the water content of sludge that leaves the sludge in a fluid condition.

Sludge Conditioning — Treatment of liquid sludge before dewatering to facilitate dewatering and enhance drainability, usually by the addition of chemicals.

Sludge Density Index — The reciprocal of the sludge volume index multiplied by one hundred.

Sludge Deposit — A deposit of solids of wastewater origin.

Sludge Digestion — The process by which organic or volatile matter in sludge is gasified, liquified, mineralized, or converted into more stable organic matter through the activities of either anaerobic or aerobic organisms.

Sludge-Digestion Gas — Gas resulting from the decomposition of organic matter in sludge removed from wastewater and placed in a tank to decompose under anaerobic conditions. Also see Sewage Gas, Sludge Digestion.

Sludge Excess — The sludge produced during recirculation in an activated sludge treatment plant that is not needed to maintain the process and not returned to the aeration tank, but is withdrawn from circulation.

Sludge Foaming — An increase in the gas in sludge in Imhoff and separate digestion tanks, causing large quantities of froth, scum, and sludge to rise and overflow from openings at or near the top of the tanks.

Sludge-Gas Holder — A tank used to store gas collected from sludge-digestion tanks, for the purpose of stabilizing the flow of gas to the burners, maintaining a nearly constant pressure, and supplying gas during periods when the digestion tanks are temporarily out of service or when gas production is low.

Sludge Index — Properly called sludge volume index (SVI). It is the volume in milliliters occupied by one gram of activated sludge after settling of the aerated liquid for thirty minutes.

Sludge Lagoon — A basin used for the storage, digestion, or dewatering of sludge.

Sludge Reaeration — The continuous aeration of sludge after its initial aeration for the purpose of improving or maintaining its condition.

Sludge Treatment — The processing of wastewater sludges to render them innocuous. This may be done by aerobic or anaerobic digestion followed by drying on sand beds, filtering, and incineration, filtering and drying, or wet air oxidation.

Sludge Volume Index (SVI) — The ratio of the volume in milliliters of sludge settled from a one thousand milliliter sample in thirty minutes to the concentration of mixed liquor in milligrams per liter multiplied by one thousand.

Snubber — A muffler designed to reduce the sound on blower intakes.

Solium Aluminate — A coagulating chemical and softening agent ($Na_2Al_2O_4$) often used in lieu of or in conjunction with alum.

Solium Hypochlorite — A water solution of sodium hydroxide and chlorine, in which solium hypochlorite is the essential ingredient.

Solids Reduction — The conversion of the more active volatile solid matter into water and gases resulting in a lower final volume of volatile solids.

Solids-Retention Time — The average residence time of suspended solids in a biological waste treatment system, equal to the total weight of suspended solids in the system divided by the total weight of suspended solids leaving the system per unit of time (usually per day).

Solution Feeder — A feeder for dispensing a chemical or other material in the liquid or dissolved state to water or wastewater at a rate controlled manually or automatically by the quantity of flow. The constant rate is usually volumetric.

Sparger — An air diffuser designed to give large bubbles, used singly or in combination with mechanical aeration devices.

Specific Gravity — The ratio of the mass of a body to the mass of an equal volume of water.

Spiral Air-Flow Diffusion — A method of diffusing air in an aeration tank of the activated sludge process where, by means of properly designed baffles and the proper location of diffusers, a spiral or helical movement is given to the air and the tank liquor.

Stabilization Pond — A type of oxidation pond in which biological oxidation of organic matter is effected by natural or artificially accelerated transfer of oxygen to the water from air.

Stable Effluent — Treated wastewater that contains enough oxygen to satisfy its oxygen demand.

Stage Aeration — Division of activated sludge treatment into stages with intermediate settling tanks and return of sludge in each stage.

Stale Wastewater — Wastewater containing little or no oxygen, but as yet free from putrefaction.

Standard-Rate Filter — A type of trickling filter in which both hydraulic and organic loadings are relatively low, usually built to operate without recycling or recirculation of wastewater.

Static Head — (1) The total head without reduction for velocity head or losses; for example, the difference in elevation of head-water, and tail-water of a power plant. (2) The vertical distance between the free level of the source of supply and the point of free discharge or the level of the free surface.

Static Suction Head — The vertical distance from the source of supply when its level is above the pump to the center line of the pump.

Step Aeration — A procedure for adding increments of settled wastewater along the line of flow in the aeration tanks of an activated sludge plant.

Stilling Well — A separate quiescent chamber connected to an open channel flow. Used to house float of flow meter device.

Stokes Law — A mathematical equation for determining the settling rate of particles.

Stop Plank — A removable wooden plank that is placed in a groove or rack to block off or permit the flow of a liquid from one compartment or channel to another.

Storm Flow — That portion of the precipitation which leaves the drainage area in a comparatively short time on or near the surface.

Storm Sewer — A sewer that carries storm water and surface water, street wash and other wash waters, or drainage, but excludes domestic wastewater and industrial wastes.

Stuck Digestor — A stuck digestor does not decompose the organic matter properly. Some refer to it as constipated. It is characterized by low gas production, high volatile acid/alkalinity relationship, and poor liquid-solids separation. A digestor in a stuck condition is sometimes called a "sour" digestor.

Suction Pipe — The inlet pipeline of a pump.

Suction Pit — A walled pit in which the suction pipe or inlet openings of a pump are placed. Sometimes called a sump or wet well.

Sulfur Bacteria — Bacteria capable of using dissolved sulfur compounds in their growth; bacteria deriving energy from sulfur or sulfur compounds.

Sump — (1) A tank or pit that receives drainage and store it temporarily, and from which the drainage is pumped or ejected. (2) A tank or pit that receives liquids.

Sump Pump — A mechanism used for removing water or wastewater from a sump, or wet well; it may be energized by air, water, steam, or electric motor. Ejectors and submerged centrifugal pumps, either float— or manually controlled, are often used for the purpose.

Supernatant Liquor — (1) The liquor overlying deposited solids. (2) The liquid in a sludge-digestion tank that lies between sludge at the bottom and floating scum at the top.

Surface Aeration — The absorption of air through the surface of a liquid.

Suspended Solids — Solids that either float on the surface of, or are in suspension in, water, wastewater, or other liquids, and which are largely removable by laboratory filtering. See Suspended Matter.

Sutro Weir — A proportional weir.

Tapered (Step) Aeration — The method of supplying varying amounts of air into the different parts of an aeration tank in the activated sludge process, more at the inlet, less near the outlet, in approximate proportion to the oxygen demand of the mixed liquor under aeration.

Torque — A twisting force on a drive shaft.

Total Dynamic Head — The difference between the elevation corresponding to the pressure at the discharge flange of a pump and the elevation corresponding to the vacuum or pressure at the suction flange of the pump, corrected to the same datum plane, plus the velocity head at the discharge flange of the pump, minus the velocity head at the suction flange of the pump.

Total Solids — The sum of dissolved and undissooved constituents in water or wastewater, usually stated in milligrams per liter.

Trade Wastes — The liquid wastes from industrial processes, as distinct from domestic or sanitary wastes.

Trash Rack — A grid or screen placed across a waterway to catch floating debris.

Treated Sewage — Wastewater that has received partial or complete treatment.

Trickling Filter — A filter consisting of an artificial bed of coarse material, such as broken stone, clinkers, slate, slats, brush, or plastic materials, over which wastewater is distributed or applied in drops, films, or spray from troughs drippers, moving distributors, or fixed nozzles, and through which it trickles to the underdrains, giving opportunity for the formation of zoogleal slimes which clarify and oxidize the wastewater.

Triplex Pump — A reciprocating pump with three single-acting clyinders placed next to each other in line, all connected with the same suction and discharge line, with valves so arranged that the intake and discharge through the pump is continuous.

Turbidity — A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays.

Ultimate Biochemical Oxygen Demand — (1) Commonly, the total quantity of oxygen required to satisfy completely the first-stage biochemical oxygen demand. (2) More strictly, the quantity of oxygen required to satisfy completely both the first-stage and the second-stage biochemical oxygen demands.

Undigested Sludge — Settled sludge promptly removed from sedimentation tanks before decomposition has much advanced. Also called raw sludge.

Vacuum Pump — A pump used to create a partial vacuum in a closed space.

Valve — A device installed in a pipeline to control the magnitude and direction of the flow. It consists essentially of a shell and a disk or plug fitted to the shell. See Cock.

Venturi Meter — A differential meter for measuring flow of water or other fluid through closed conduits or pipes, consisting of a venturi tube and one of several proprietary forms of flow-registering devices. The difference in velocity heads between the entrance and the contracted throat is an indication of the rate of flow.

Vertical Pump – (1) A reciprocating pump in which the piston or plunger moves in a vertical direction. (2) A centrifugal pump in which the pump shaft is in a vertical position.

V-Notch Weir – A triangular weir.

Volatile – Capable of being evaporated at relatively low temperatures.

Volatile Acids – Fatty acids containing six or less carbon atoms, which are soluble in water, and which can be steam-distilled at atmospheric pressure. Volatile acids are commonly reported as equivalent to acetic acid.

Volatile Solids – The quantity of solids in water, wastewater, or other liquids, lost on ignition of the dry solids at 600 degrees Centigrade.

Waste–Gas Burner – A device in a wastewater treatment plant for burning the waste gas from a sludge-digestion tank.

Wastewater – The spent water of a community. From the standpoint of source, it may be a combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present. In recent years, the word wastewater has taken precedence over the word sewage.

Wastewater Analysis – The determination of chemical composition, concentration, and biological condition of wastewater and treatment effluents.

Wastewater Influent – Wastewater as it enters a wastewater treatment plant or pumping station.

Wastewater Treatment – Any process to which wastewater is subjected in order to remove or alter its objectional constituents and thus render it less offensive or dangerous.

Water Quality – The chemical, physical, and biological characteristics of water with respect to its suitability of a particular purpose. The same water may be of good quality for one purpose or use, and bad for another, depending on its characteristics and the requirements for the particular use.

Weir — (1) A diversion dam. (2) A device that has a crest and some side containment of known geometricshape, such as a V, trapezoid, or rectangle, and is used to measure flow of liquid. The liquid surface is exposed to the atmosphere. Flow is related to upstream height of water above the crest, to position of crest with respect to downstream water surface, and to geometricof the weir opening. See Weir Flow Formulas.

Well — An open shaft of varying depths, may be wet or dry.

Wet Well — A compartment in which a liquid is collected, and to which the suction pipe of a pump is connected.

Y-Strainer — A device designec to remove all particular matter from chlorinator feed water.

Zeta Meter — Electronic measuring device designed to measure the surface electrical charge of colloidal-sized particles.

Zooglea — A jelly-like matrix developed by bacteria. A major part of activated sludge floc and of trickling filter slimes.

Zoogleal Matrix — The floc formed primarily by slime-producing bacteria in the activated sludge process or in biological beds.